MACHINERY.

February, 1904.

SHOP NO. 3 OF THE BULLOCK ELECTRIC MFG. COMPANY.

THE works of the Bullock Electric Mfg. Co., although nominally in Cincinnati, Ohio, are really in the outskirts, in the pleasant suburb of South Norwood. The buildings constituting the works are of unusually attractive appearance (for a manufacturing plant), being built of buff pressed brick, with well-kept grounds. A recent addition, with which this description has to deal, is the heavy machine and erecting shop No. 3, or rather that part which was completed during the past year. A general view of the west end of shop No. 3 and of the service building, appears in Fig. 1. As intimated the new shop is not yet completed, the plan being to extend it 300 feet further east, but since the addition will be in harmony with the completed section, a description of the latter will largely apply to the whole structure.

Shop No. 3 was erected for building heavy generators and rotary converters—the former in the largest sizes up to 10,000 K. W. if demanded. The section shown in the plan view, Fig. 2, is 175 feet wide and 200 feet long. The east wall is a temporary wooden structure which will be torn down when the extension is built. The middle bay, as shown in the views, Figs 3, 4 and 5, is very high and wide. The width is 77 feet 10½ inches and the clearance beneath the hook of the 50-ton traveling crane is 50 feet. The north bay is 48 feet 9¼ inches wide and is served by a traveling crane of 30 tons capacity. The south bay is of the same width and is served by a 20-ton crane. Both cranes in the side bays have a lift of 26 feet. The roof is of the monitor type, with four skylights and windows in the sides of the monitor. Fully 50 per cent. of the side walls and of the permanent west end wall below the gable is glass. The sides of the monitor are practically all glass, and the skylights of translucent fiber that pierce both slopes of the monitor roof and each slope over the side bays, are continuous from one end of the shop to the other. The result is that a vast flood of light is admitted from all directions, leaving little to be desired in this respect. A valuable feature of the translucent fiber skylight is that it is not affected or broken by severe hailstorms or the vibration of the building, but its chief advantage is that the light admitted is softened and subdued, which is particularly agreeable in summer.

The shop is heated in winter by the Buffalo Forge hot air system. The conduits are carried through the side bays at a height of about 35 feet from the floor and the air is discharged at this height, the nozzles not being carried down near the floor. The heater and circulating fan are located in the northeast corner where they will be quite centrally located when the extension is built. The same apparatus is used in summer to cool the shop, cool air being blown through the pipes the same as warm air is in winter. The air in summer is drawn from the outside and passed through pipes around which cold water circulates. This system was found to be quite successful during the past summer and very agreeable to the workmen.

The floor has several features of interest. The foundation consists of rock concrete 2 feet deep in which the sleepers are laid and grouted. On the sleepers are laid 2-inch oak plank, This applies to the main floor. The testing floor in the northwest corner where the large machines are subjected to running tests, has a foundation of rock concrete 16 inches deep in which are buried at 5-foot centers 12-inch steel I-beams. On top of the I-beams are laid 2-inch planks and on these are laid 2-inch pine planks or flooring. The cast-iron floorplate in the middle bay, upon which the portable milling machines and slotters are used, is 60 feet long and 27 feet 8½ inches wide. It consists of 25 sections like that shown in the working drawing, Fig. 6. The T-slots in each section are continuous, but at the ends a transverse groove or slot 2½ inches (1¼ inches on each section) is provided for the convenient removal of chips and other debris. The general views, Figs. 4 and 5, show the floorplate with tools at work and Fig. 7 shows the floorplate with the rotor of a 3,200 K. W. generator in the foreground. In this view the 10-foot radial drill at the left is mounted on a separate floorplate of three sections. It, of course, may be shifted to any part of its floorplate required for advantageous working, the stump being provided with a circular base with bolt holes for this purpose.

All tools and machines are electrically driven by independent motors save, of course, the pneumatic hammers and drills used on the erecting floor. The electric power wires are laid

Fig. 1. View of West End Shop No. 3, Bullock Electric Mfg. Company. Service Building at Left.

in two wiring tunnels or subways located on each side of the middle bay. The location of the principal machines and of the testing floor and floorplate is such that the wiring tunnels serve them with comparatively short leads. Inclosed arc lamps are used and the wiring for these and the traveling cranes is, of course, carried overhead.

cranes are preferably used for loading and unloading cars unless otherwise employed.

The largest machine tool in the shop is the 44-foot pit lathe indicated in the plan and shown individually in Fig. 8, working on an armature shield and support for a 3,200 K. W. alternating current generator. The machine can be used either

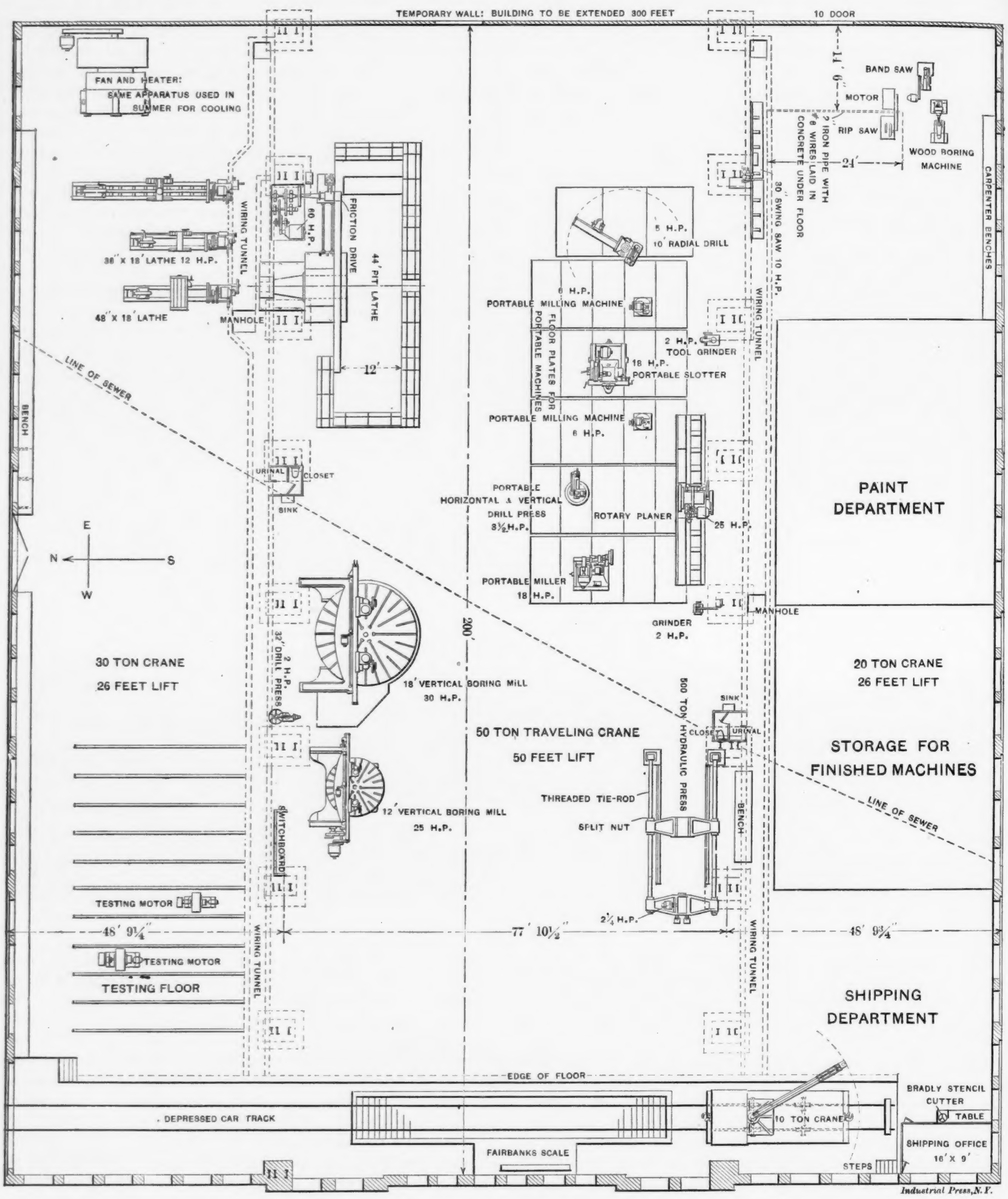

Fig. 2. Floor Plan of Shop 3—Bullock Electric Mfg. Company.

A railway switch enters from the north side and crosses the west end. The tracks are depressed so that the floor of a flat car is on a level with the shop floor. A Fairbanks track scale enables all car weights to be determined independently of the railway company; also all castings received from the foundry both individually and in bulk. A 10-ton derrick car is part of the plant equipment for handling heavy parts and is indicated in the shop plan, but of course the shop traveling

as a lathe or as a boring machine, being used in the latter capacity in this instance, since the work remains stationary while the boring tools revolve with the faceplate. The faceplate is 30 feet diameter and the pit will permit a casting 44 feet diameter and 12 feet long to be swung. The novel feature of the lathe is the friction drive, power being transmitted to the periphery of the faceplate by a friction wheel or roller 18 inches diameter and 15 inches long. A slotted cast-iron

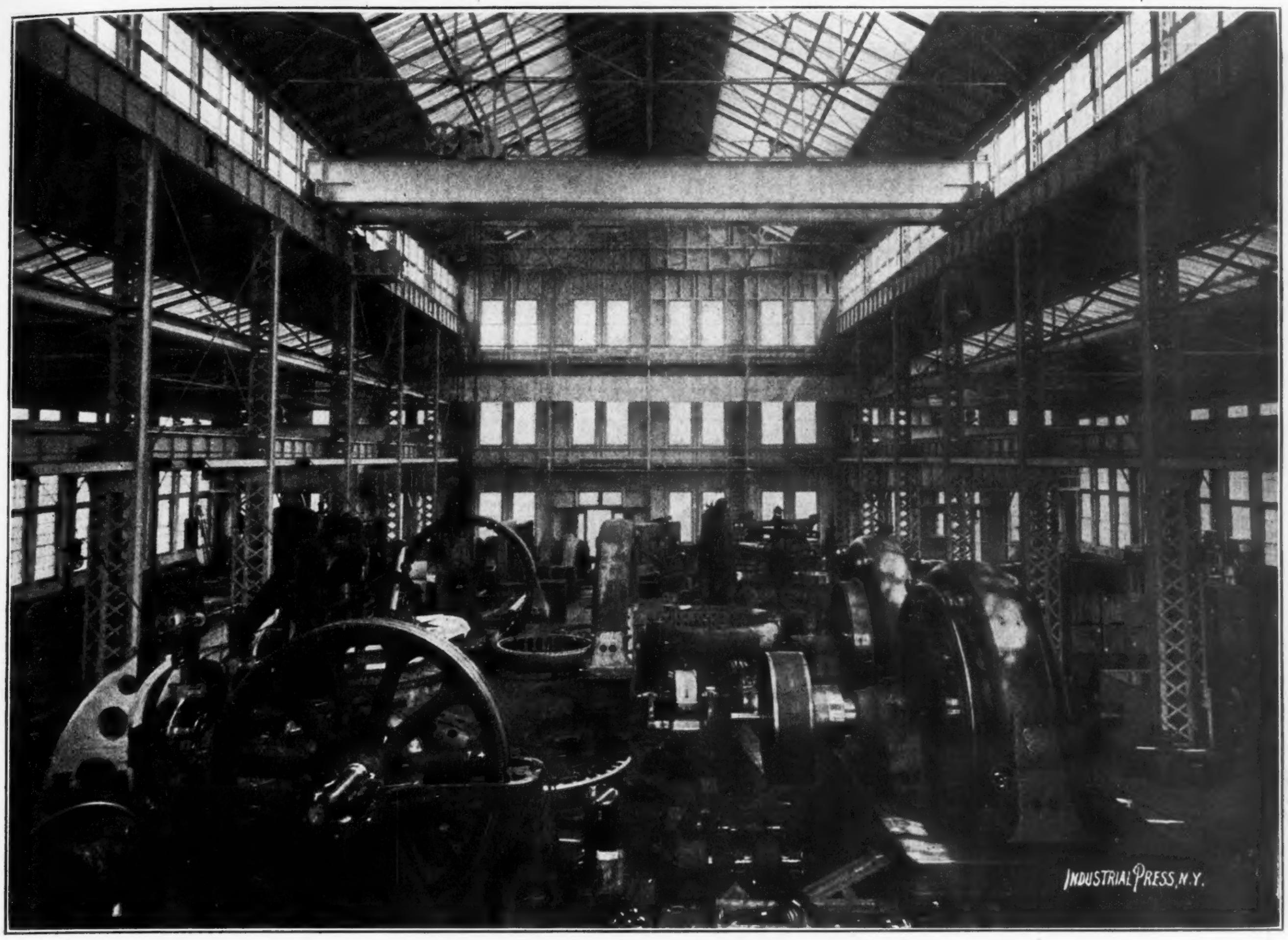

Fig. 3. General View of Shop, looking East.

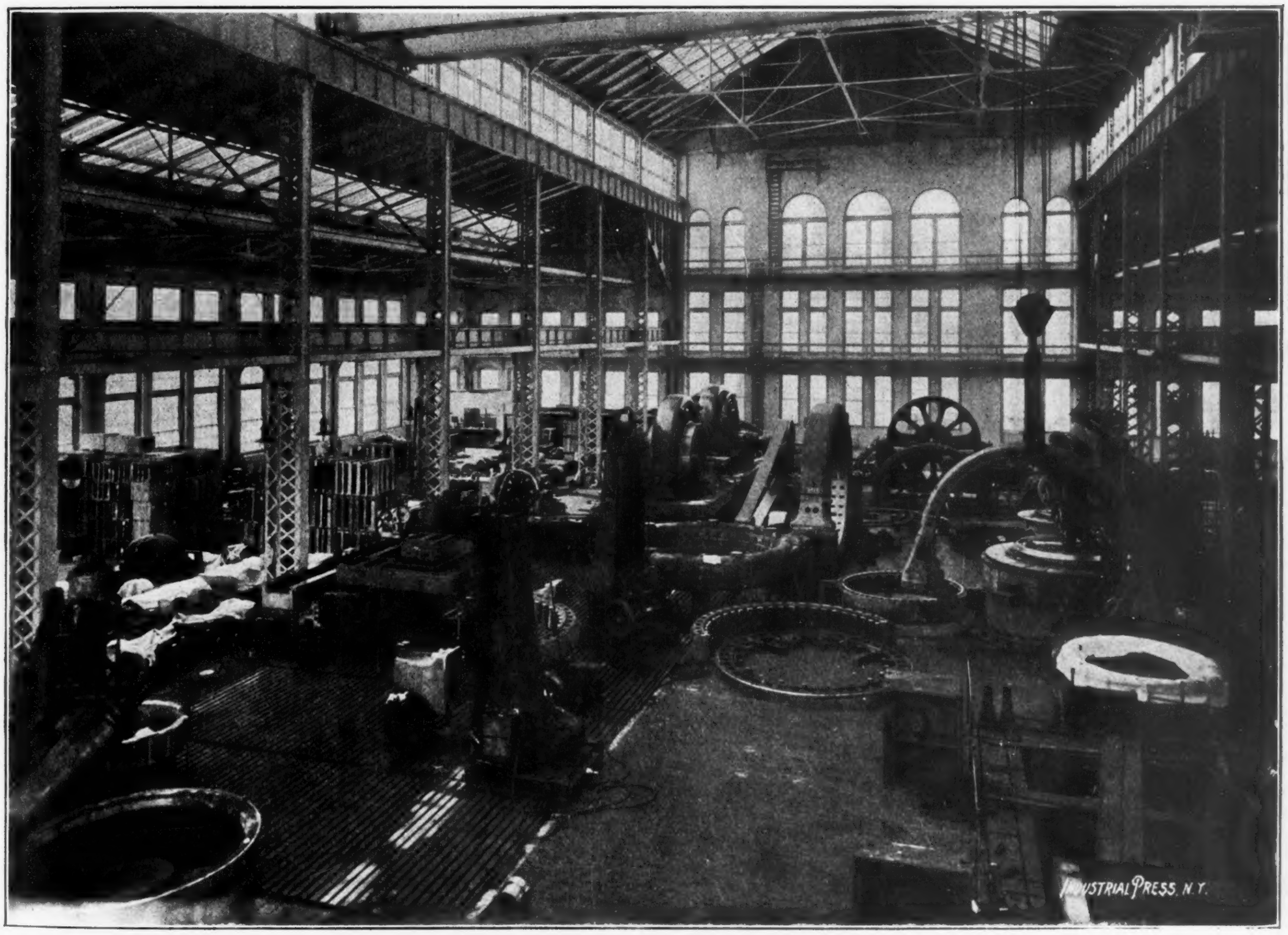

Fig. 4. General View, looking towards Southwest Corner.

Fig. 5. General View of Shop, looking Northwest.

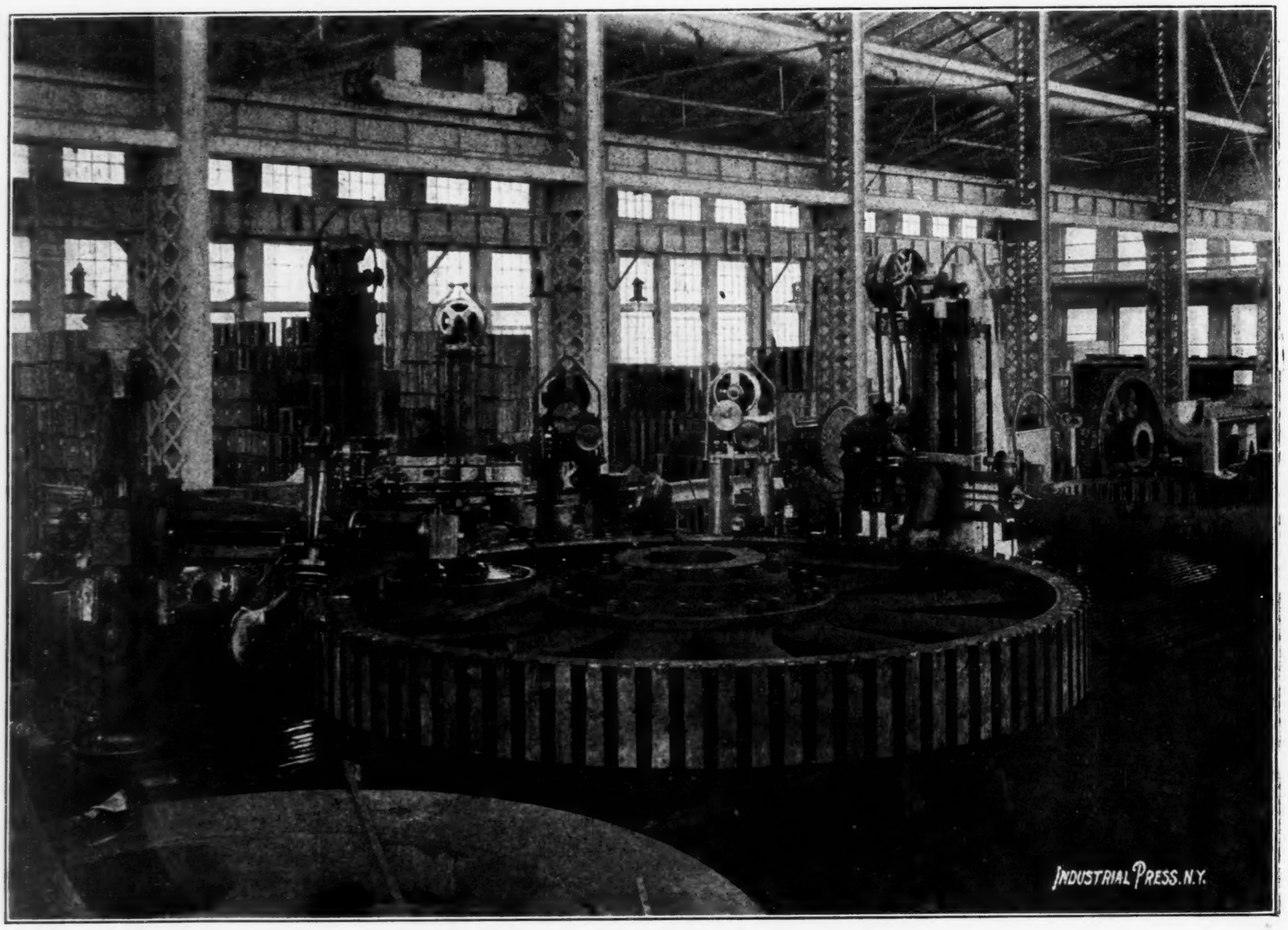

Fig. 7. Floorplate, showing Rotor of 3,200 K.W. being Machined.

floorplate is laid on three sides of the pit for the erection of work that is to be bored and for supporting the cutting tools when work is swung on the faceplate. The floorplate will be used for the latter purpose only when the full capacity of the pit is taken up. Ordinarily the turning tools are supported on massive cast-iron columns resting on the floor of the pit. The feed mechanism of the tool carriages is driven by an independent motor controlled by a feed regulator so that any rate of

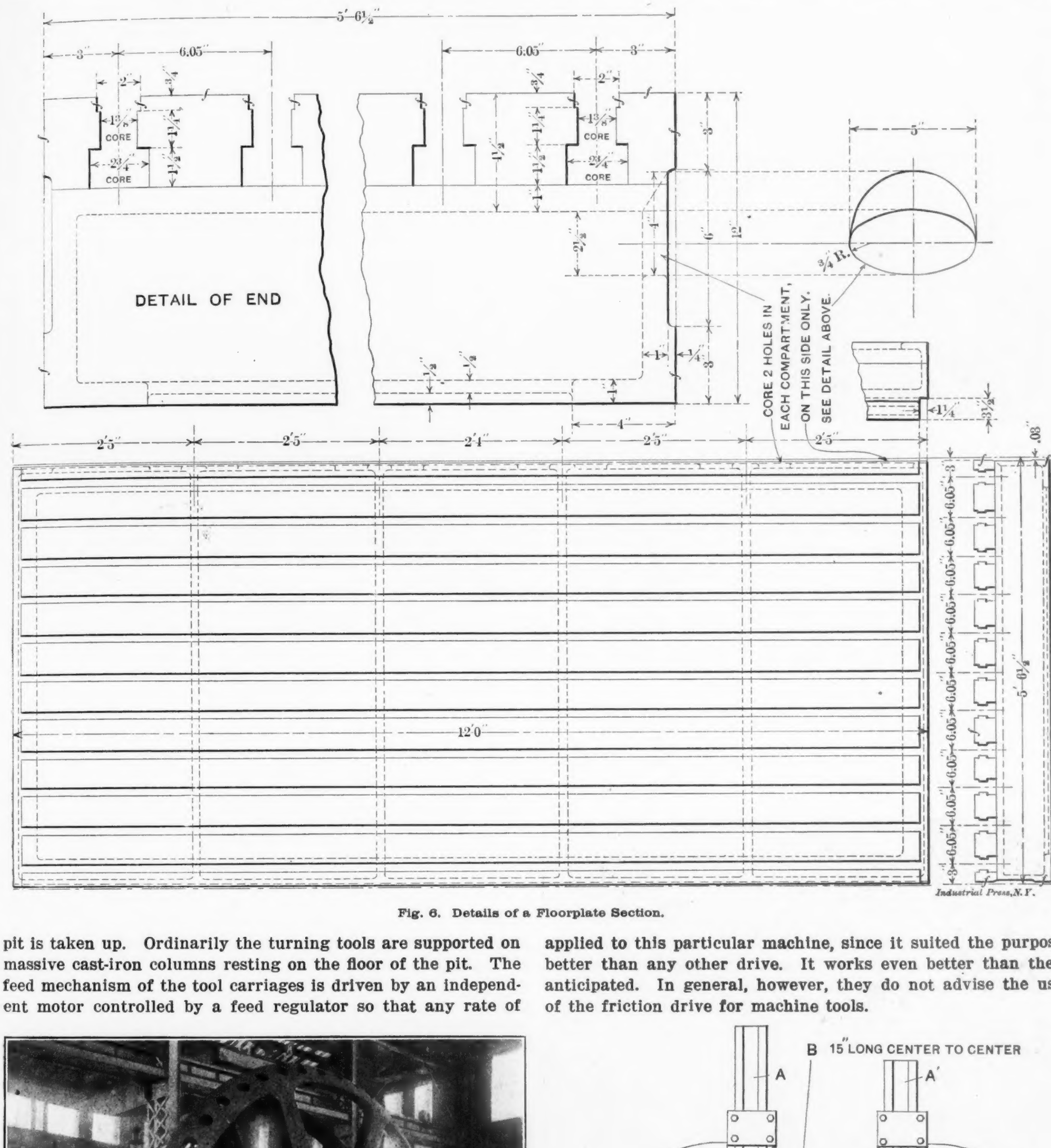

Fig. 6. Details of a Floorplate Section.

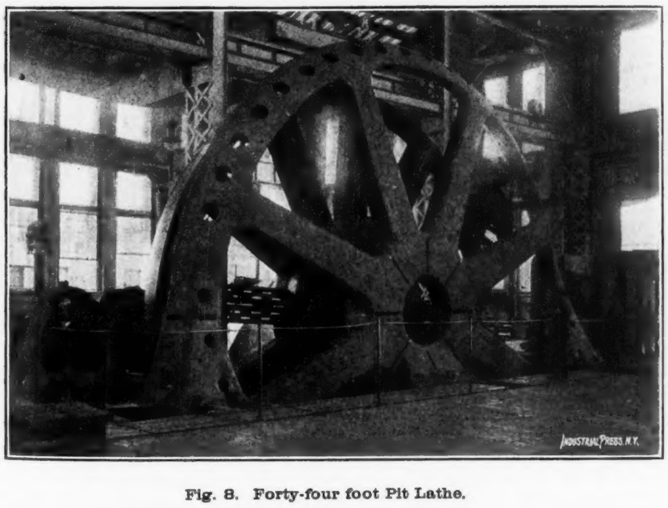

Fig. 8. Forty-four foot Pit Lathe.

feed from 3-64 inch to 2¾ inches per minute may be gotten and strictly in accord with the movement of the faceplate. The floorplate is also used for an outboard bearing or support for boring bars and mandrels when turning or boring large rotors or flywheels. The total weight of the lathe is estimated at 480,000 pounds. Fuller particulars of the friction drive were contributed by Mr. John M. Barnay in the January, 1903, issue. The company are satisfied with the friction drive as applied to this particular machine, since it suited the purpose better than any other drive. It works even better than they anticipated. In general, however, they do not advise the use of the friction drive for machine tools.

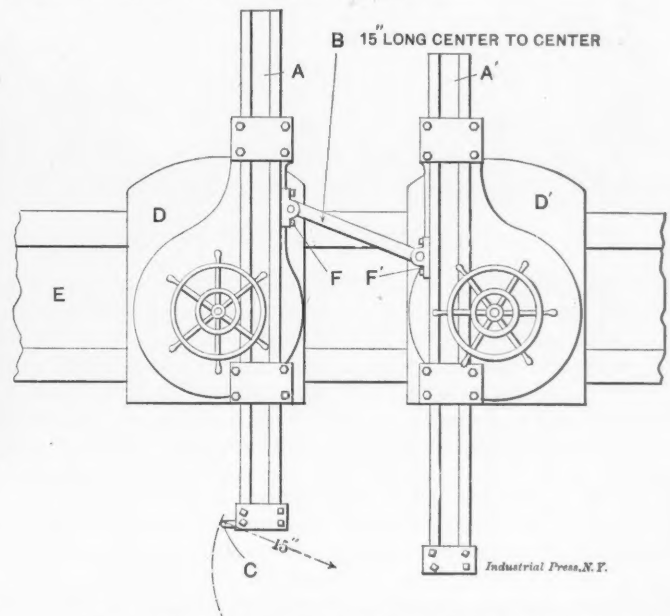

Fig. 9. Boring Mill Attachment for Boring Spherical Seats.

On the same side of the middle bay as the pit lathe are two vertical boring mills of 12 and 18 feet capacity respectively. Both these mills have been adapted to boring spherical seats for the self-aligning bearings used on all large generators. The device is shown in Fig. 9 and consists essentially of the bar or link *B*, which is made of the required radial

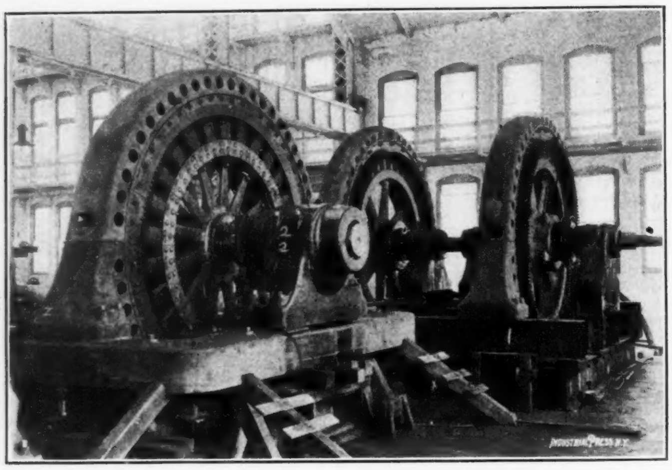

Fig. 10. Generators on Erecting Floor, in Position for Testing.

length from the centers of the pin holes in the ends, links of different radii being provided to suit the work. The blocks *F F'* are secured to the boring bars by two screw bolts each and either bar can be used for boring a spherical seat. The bar *A* is supposed to be so employed in the sketch and in that case the slide *D* is made free to move on the cross-rail *E*, the cross-feed nut or screw being disengaged for that purpose. The slide *D'* is clamped to the cross-rail and the bar *A'* remains stationary so that the pin at *F'* forms a pivot about which the link *B* swings as the bar *A* feeds down. Therefore the whole bar, including the point of the cutting tool *C*, moves in an arc of the same radius as that of the link *B*, which, in this case, is supposed to be 15 inches. The same scheme may be employed for spherical turning or for the generation of cycloid curves if required.

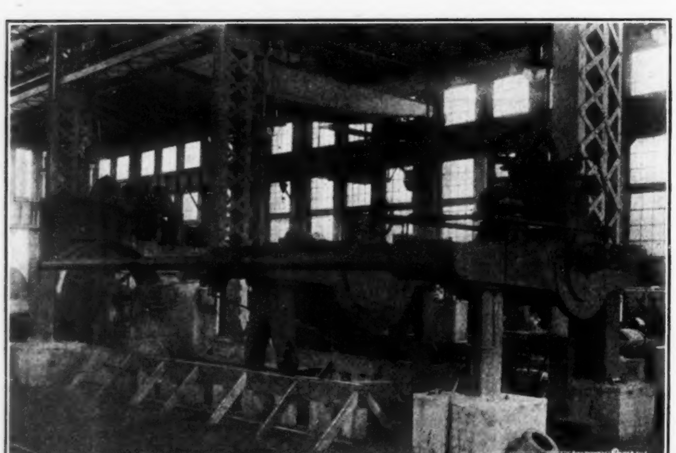

Fig. 11. Hydraulic Press, Motor-driven, for Forcing Fits.

Another feature of these boring mills which is of minor interest is that the counterbalance weights are not supported by pulleys on the frame or housing in the usual manner. When this is done it requires that pits be dug and bricked up for the reception of the weights when the cross-rail is raised to the top of the mill. In these cases the pulleys are mounted on the shop girders at a distance of about 25 feet from the floor and close to the columns. In this manner ample movement is gotten without making pits.

The construction of the testing floor has already been described. Fig. 10 shows three heavy generators in position on it for testing. The machine in the foreground is a 3,000 K. W., 50-cycle, three-phase, 2,400 volt, 231 R. P. M. waterwheel type alternator for the Kern River Co., California, and in the background are two 1,000 K. W., 25-cycle, three-phase, 375 volt, 94 R. P. M. engine type alternators for the Scioto Valley Traction Co.

The heavy Watson-Stillman Co. hydraulic press for forcing fits, shown in Fig. 11, is located on the opposite side of the shop from the testing floor and near the shipping department. It has a capacity up to 500 tons and is motor driven. The yoke is a heavy steel casting and is locked to the longitudinal tie rods by split nuts. The rods are cut with a coarse buttress thread and the halves of the split nuts are similarly threaded and operate substantially the same as the split nuts in a lathe apron. Fig. 12 shows one end of the yoke more in detail. *A* is the yoke, *B* detachable handle for operating the nuts, *C* is a rod connecting the opposite side so that the nuts on both sides work in unison, *D D'* are the halves of a nut, and *E* is a screwed tie-rod.

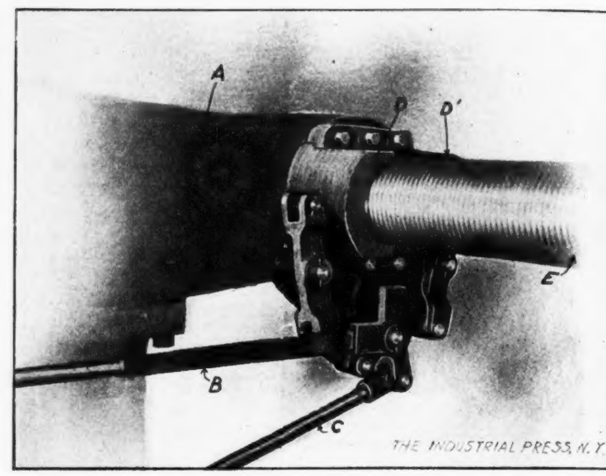

Fig. 12. Detail of Split Nut in Hydraulic Press Yoke.

Shop No. 2, which was recently badly damaged by fire, is being rebuilt and enlarged so that it will be about twice as long as the old structure. The new building will be 200 feet long and 140 feet wide and two stories high.

A dining room is provided for the employees in all the departments. The men may bring their own lunches and eat them in the dining room, or buy a well-cooked, palatable meal from the company at a nominal cost. Shower and plunge baths, lockers and the other modern conveniences are provided that so sharply differentiate the present generous policy of up-to-date concerns from that of the old regime.

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The United States consul at Liege, Belgium (Mr. James C. McNally), says that the catalogue system of advertising American goods is not of much avail with the merchants of that

Fig. 13. Storage Department.

city. The buyer wants to see the goods in bulk so that he can personally examine their details, and he wishes to listen to the arguments of the American drummer, that is, personal efforts are necessary to put American goods on that market.

TOOL MAKING.—3.

REAMERS (Concluded).

E. R. MARKHAM.

Shell Reamers.—The larger sizes of chucking reamers are oftentimes made in the form of "shell reamers." As several reamers may be made to be used with the same arbor, there is a great saving in cost of stock. But in order to prevent the reamer turning on the arbor when in use a slot is cut across one end, as shown in Figs. 19 and 20, and this engages with a pin passing through the arbor, or a tongued collar on the arbor. Owing to the liability of change in size of hole in the reamer when hardened, it is necessary to leave a small amount of stock in the hole, to be ground out after hardening; or the hole may be made tapering and the arbor given a corresponding taper to fit the hole.

When making shell reamers, select stock enough larger than finish size to allow of turning off all the decarbonized portion. The piece should be placed in a chuck on the lathe and a hole drilled and reamed through it 1-16 inch smaller than finish size. It should then be placed on a mandrel and turned to a size 1-32 to 1-16 inch larger than finish, after which it

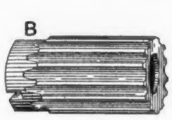


Fig. 19.

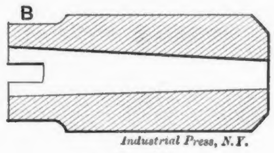


Fig. 20.

should be annealed. This is to eliminate any tendency of the piece "going" to any great extent when hardened. This process should be employed when making almost any piece of work that we wish to prevent from altering in shape or size of hole when hardening; it also helps to decrease the tendency to crack from internal strains when the article is hardened.

After annealing, the piece is placed in the chuck and the hole finished to grinding size, which ordinarily would be about .005 inch smaller than finish. If a taper-shaped hole is desired, it may be bored and reamed to the desired size and taper. When this form of hole is made in a reamer, it is not generally considered necessary to make any allowance for grinding, as any slight inequality of size would be taken care of by the shape of the hole in the reamer and arbor it is to be used on. When the hole is finished the blank may be placed on a mandrel, the ends faced to the desired dimensions, and the reamer part turned to a size .010 to .015 inch larger than finish size. The portion marked *B* at the end of reamer may be turned to finish size. If we are making a rose reamer, the cutting end should cut to the proper bevel.

Before cutting the flutes that form the cutting edges it is advisable to cut the tongue slot in the end. To accomplish this the reamer blank may be placed in the chuck on the index head spindle of the milling machine; and as this slot must be central, extreme care should be exercised in setting the machine and cutting it. Select a cutter somewhat narrower than the desired width of slot; set this as centrally as possible with the end of reamer, then cut across the end. Give the index pin handle 20 revolutions, thus turning the work one-half way around, and cut across again. The width of the slot that has been cut may now be measured and the saddle moved one-half the difference between the size cut and that desired. However, before taking the final cuts measure the distance from the slot to each edge of the reamer to ascertain if the piece of work is chucked true. If not, we will be obliged to cut each side of the slot to a measurement from the outside of the piece. After removing the burr thrown up in the hole by the cutting of the tongue slot, the reamer blank may be placed on a mandrel and the grooves cut. The direction given for cutting grooves of solid reamers apply to shell reamers.

If the reamer is pack-hardened the results will be more satisfactory than if any other method known to the writer is used, for the danger of cracking is eliminated and the liability of the size of the hole being affected is reduced to the minimum. However, if this method cannot be used excellent results may be obtained by heating in a muffle furnace, or in a tube in a blacksmith's forge. The reamer should be heated uniformly to a low red and plunged in a bath of water or brine—preferably the latter—from which the chill has been removed.

When the reamer is taken from the fire, and before plunging in the bath place it on a hook of the form shown in Fig. 21 in order that no part of it may be kept from the action of the water when cooling. If the reamer is larger than 1¼ inch diameter it should be removed from the bath when it ceases "singing" and be plunged into a tank of oil and allowed to remain until cool. When it is removed from the bath, whether water or oil, hold it over a fire, revolving slowly until heated sufficiently to remove the tendency to crack from the internal strains set up by hardening. Ordinarily it is not necessary to draw the temper of rose reamers. Fluted reamers may be drawn to a straw color.

The hole should be ground to size—provided it is to be ground—and the reamer placed on an arbor and ground according to instructions given for grinding reamers.

Arbors for Shell Reamers.—Fig. 22 shows an arbor for use in holding a shell reamer, having a straight hole. The smaller sizes are usually made from tool steel, while the larger ones are sometimes made from a stiff grade of machinery steel. If tool steel is used a cheap grade answers the purpose as well as a more costly article.

Make the tongues used in keeping the reamer from turning, on a separate piece from the arbor itself. Make a collar from tool steel and cut the tongues on the end as shown. These must, of course, be central with the sides of the collar. The collar may then be placed on the arbor and the pin hole drilled and reamed, after which it is removed and spring-tempered. It may now be placed on the arbor and the pin driven in place.

Roughing Reamers.—Very often when large holes are to be produced from solid stock it is found more economical to drill a hole with a drill smaller than the desired size then to enlarge it with a roughing reamer than to attempt to drill it to size. The two operations can be done more quickly than the one and then again the roughing reamer, being short and

Fig. 21

Fig. 25

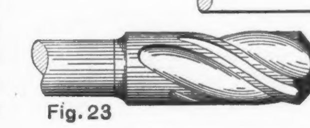


Fig. 23

Fig. 22

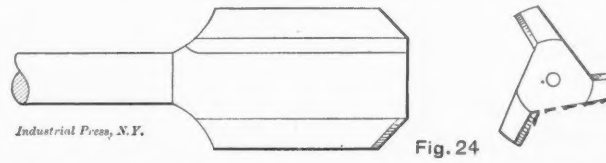


Fig. 24

strong, will in a great measure true up the hole which may have run when drilling. This form of reamer is extensively used on screw machines and chucking machines, for enlarging cored holes.

The grooves are cut both straight and spiraling. Straight grooves are generally cut when the material to be machined is cast iron. When they are to be used for cutting steel, spiral grooves give best results. When the reamer is to be used for cutting steel it is best to cut oil grooves, as shown in Fig. 23, as these grooves convey lubricant to the cutting edges, and as they remove a portion of the land the frictional resistance is reduced.

When the tool is to be used for machining large holes—those above 2 inches—the form shown in Fig. 24 is preferred by many mechanics for use on either cast iron or steel, the grooves being straight as shown. The flutes are large and easily accommodate the chips and at the same time convey the oil or other lubricant to the cutting edges.

As the use of this form of reamer is generally followed by a boring tool, to true up the hole in case it may have run, it is not essential that it cut exact as to size, and consequently it need not be ground after hardening. However, if it is considered necessary to grind to size a sufficient allowance may be made when turning in the lathe, and as the centers are left in the piece, the grinding is a simple matter.

Formed Reamers.—Formed reamers are used to ream a hole of irregular contour. They are employed very extensively in shops where fire arms are manufactured, for reaming the end of the barrel that goes in the frame to receive the shell, and are then generally termed "chambering reamers." That these reamers may retain their size and shape for as long a period as possible they are made in sets. A roughing tool cuts out the principal part of the stock, then a reamer a trifle smaller than finish size is used, leaving a very small amount to be removed by tne finishing reamer.

Fig. 26

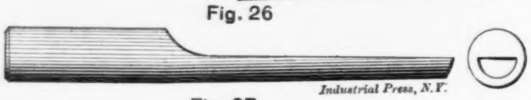


Fig. 27

Industrial Press, N.Y.

As it is necessary to machine the formed hole in exact alignment with the rifled hole in the barrel the reamer must be provided with a pilot of the exact size of the hole at the tops of the lands of the rifling. Such a reamer is shown in Fig. 25. And to prevent the lands of the rifling from becoming marred by the pilot, this part is made a trifle small, and a sleeve is placed on the outside of it. This does not revolve when the tool is cutting; the pilot proper being a running fit in the hole in the sleeve revolves in it. But the tendency of the reamer is to throw a burr at the end where it stops cutting, and should we attempt to draw the sleeve back through this burr it would get stuck and in all probability spoil the rifling. To avoid this we must remove the burr and for this purpose teeth are cut on the sleeve on the end toward the reamer, as shown. A pin is driven through a hole in the pilot, just beyond the end of the sleeve, thus leaving the sleeve free when the pressure on the reamer is ahead; and grooves are cut in the end of the sleeve toward the pin, as shown. Now when we draw back on the reamer the grooves in the sleeve engage with the pin, the sleeve turns with the reamer and the teeth on the opposite end cut away the burr. As the teeth are to be on the opposite end from what general practice would call for, attention must be given as to which way they face, so that they may cut.

Reamers of this character must be exact as to shape, and it is therefore necessary to make them to gages. First, a sheet steel gage is used, to shape the general outline to; then a receiving gage, which consists of a block having a hole of the right size and shape in it, in order that the fit may be easily observed. A portion of this block must be cut away, leaving a trifle more than one-half the hole in the block.

Owing to the peculiar shape of a reamer of this style, and to the fact that it is so slender that it would not be possible to use a forming tool to shape it, it may be roughed somewhere near to shape with the ordinary lathe tools, but the finishing to shape and size must be done by means of hand tools. Where these tools are made in quantities sufficiently large to warrant the outlay a special form of turning lathes may be made, but for ordinary purposes the method described is used.

To prevent change of size, and springing, it is advisable to harden tools of this character by the pack-hardening method. If this cannot be done, however, the piece should be heated in a muffle furnace, or in a pipe in a forge, and dipped in luke-warm brine. If shape or size is altered it may be fitted to gage by oilstoning.

Taper Reamers.—Taper reamers are used for various classes of work. We have in common use roughing taper reamers, finish taper reamers, dowel pin taper reamers, etc. These are made with straight flutes, as shown in Fig. 26, and also with spiral flutes. Then we have the half reamer with only one cutting edge, as shown in Fig. 27.

Ordinarily the roughing taper reamer is simply intended as a means of removing stock so that the finish reamer will not have much work to do, that it may maintain its size and shape as long as possible, and cut a smooth hole accurate as to size. It is made of a form that breaks the chips into short lengths, that is, in the form of what is sometimes termed a "multiple counterbore," as shown in Fig. 28. Each of the bodies, *B*, *B*, is straight and a trifle larger than the one preceding it. The stock at the end of the body is cut somewhat below the size of the next smaller body, by cutting grooves, *A*, *A*, as shown, with a parting tool whose corners are slightly rounded to prevent cracking when the reamer is hardened. It is customary to give roughing reamers of this character four flutes. The ends of the steps are given clearance so that they may be cut, which is done by filing. The commercial "roughing taper reamer" is usually made as shown in Fig. 29; this has a thread cut its entire length, as shown, to break the chip.

In cutting the thread which should be left-hand, use a square-thread tool having its corners slightly rounded. The tool should be about 1-16 inch thick; the thread cut about 1-32 inch deep. After the grooves are cut the reamer may be hardened, the temper drawn to straw color and the reamer ground to size and to the proper taper. Then it may be given clearance for cutting, which is done by grinding, as explained under grinding fluted reamers, excepting that the grinding may extend to the cutting edge of the tooth. The proper clearance for cutting extends back about 1-32 to 1-16 inch from the cutting edge—according to size—the remainder of the tooth being given greater clearance.

Taper reamers intended for reaming holes to receive taper dowel pins are made of the same form as a finish taper reamer, or as a "half" reamer like that shown in Fig. 27. The latter form is in general use in many shops, while the commercial article is usually made of the first form.

When exactness of shape is desired the reamer must be made of the form shown in Fig. 30, leaving the portion at small end full size until the reamer is ground, in order to preserve the center. After being ground to size and shape the extra portion may be ground away, leaving it of the shape shown in Fig. 27. When milling articles of this sort it is necessary to support them from the milling machine table with the adjustable support furnished with the machine, or by some means to prevent springing from the pressure of the cutter.

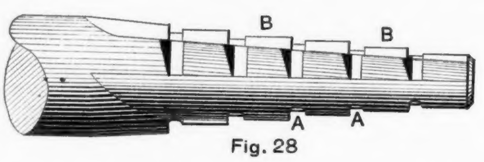


Fig. 28

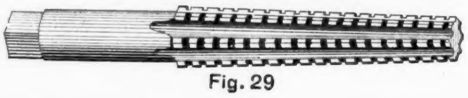


Fig. 29

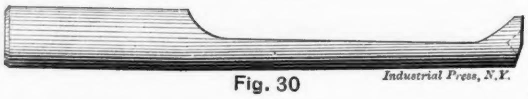


Fig. 30

Industrial Press, N.Y.

When hardening, heat very carefully in a tube in the fire, then dip in the bath with the reamer inclined, as shown in Fig. 31, the heavy portion being down to cause it to cool quickest. This keeps it straighter than if it were dipped in a vertical position; the angle of inclination cannot be given, it must be determined by experiment.

If the reamer is ground in a dry grinder care must be exercised that a coarse, free cutting wheel be used; for the reamer will spring if heated, as all of the heat would be applied to one side. After grinding the round portion may be honed, being careful to come only to the cutting edge. The honing is to relieve the bearing surface, or rather to reduce it.

Finish Taper Reamers.—Taper reamers used for finishing holes are usually made to appear like Fig. 26, although the

grooves are sometimes cut with a right-hand spiral, which tends to make them cut a smoother hole, especially if the stock is porous, or the walls of the hole imperfect. A spiral of this kind would not do on a straight fluted reamer; the tendency would be to draw into the hole being reamed faster than the reamer could cut, and consequently when the flutes of straight reamers are cut spiraling they are given a left-hand spiral. But on account of the inclination of the sides of a taper reamer the amount of spiral usually given would not cause it to draw in, although it might cause it to cut somewhat easier than if the flutes were straight.

Square Reamers.—This form of reamer is used mostly by makers of gun barrels and similar work. It differs from the other forms of reamers in that the cutting is done on the end nearest the shank. The reamer is pulled through the hole rather than pushed through, as is generally the case. This form of reamer is sometimes termed a "chip reamer" on account of the method used in enlarging the size of the hole cut

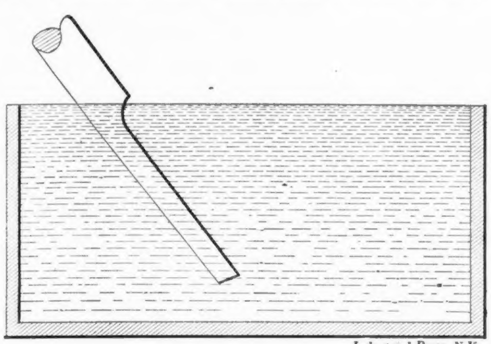


Fig. 31. Proper Position of "Half" Reamer in Hardening Bath.

with it. A chip of wood is placed on one side, as shown in Fig. 39. When the size of the hole should be increased a small amount a piece of paper—or tissue paper—is placed between the chip and reamer.

This form of reamer is turned a size somewhat larger than the size across corners, then milled square. When large reamers are made a convex cutter is used to mill the sides concave; but small reamers are milled square on their sides and the concave surface is obtained by the emery wheel when grinding. The shank is made short and after the reamer is ground to size it is brazed or welded to a long shank.

After the reamer is hardened it is placed in the grinder, the corners ground to size, and the sides also ground. The concave shape is given by the face of the emery wheel—and should not be carried quite to the corners. The end toward the shank is made slightly tapering for a short distance for the cutting portion. Now by using a flat oilstone we can hone the reamer slightly flat at the corners, and this prevents its digging into the work. This form of reamer is used to remove a very small portion of stock at each cut and will cut a very smooth hole.

Single Lip Reamer.—This form of reamer is used very extensively in some shops, while in other shops it is never seen. For certain purposes it is more satisfactory than any other form of reamer. As it has but one cutting edge its action is similar to that of a boring tool used for lathe work. And as more than one-half the stock is left on the reamer when it is milled for the cutting edge it is supported in the hole, and if properly started, will not run when cutting, but is bound to produce a straight hole.

The form of single lip reamer shown in Fig. 32 is the one commonly used. Select stock somewhat larger than finish size. When turning in the lathe leave portions *A* and *B* somewhat larger than finish, to allow of grinding. *C* is turned to dimensions given, because it is not essential that it run true. The size, and any distinguishing marks desired, may be stamped here.

When milling for the cutting edge do not mill away quite one-half the stock, as more than one-half the circumference of the reamer is required to support it in the hole when cutting. If the countersunk hole (center) in the cutting end is made small we need not mill away sufficient stock to disturb it. If, however, the center should be large and the reamer a small one, we can mill it as shown in Fig. 33, leaving it this shape until after it is ground to size. Then the end containing the deep center may be removed by grinding, leaving the reamer as shown in Fig. 32. It is necessary to bevel the end of the cutting portion as shown, while one-half of the end is beveled off so as to be out of the way, or it would strike on the opposite side of the hole from the cutting edge and prevent the reamer penetrating the stock. When hardening reamers of this character it is important that they be hard the entire length of body (*A*, Fig. 32) or they will be apt to rough up in the hole being reamed. Unless they are small the temper need not be drawn.

Single lip reamers are made at times with a pilot, as shown in Fig. 34. This pilot, which is considerably smaller than the hole it is to pass through and which is to be reamed, fits a bushing at the further end of the hole. The bushing receiving the pilot guides the reamer and causes it to cut the hole at the desired location. This form is made the same as the reamer without pilot; enough stock is left on pilot to finish to size by grinding after hardening. It is necessary to neck down at the end of the pilot nearest the cutting portion so that the reamer may be given clearance by filing, and also to allow the emery wheel to pass over the pilot when grinding.

Reamers with Inserted Blades.—Generally speaking it is not good practice to make small reamers with inserted blades. Large reamers are, however, made this way (see Fig. 35) as a matter of economy. Not that the first cost is any less; but it is possible, when the blades are worn so that the reamer cuts small, to insert new blades at a cost much less than that of making a new solid reamer. Then again the reamer may be so made that the blades may be made to cut larger by moving them. It is then called an expanding reamer.

The body of an inserted-blade reamer may be made of a cheap grade of tool steel, or of a high-carbon machine steel. It would not be good practice to make the body of ordinary low-carbon machine steel, as it would not resist the pressure of the blades on the sides of the slots when the reamer was in use; and if they became loose in the slots the reamer would be of no use, as the blades would bite into the walls of the hole and prevent the reamer cutting and in all probability spoil the piece being reamed.

After turning to the desired size the slots may be milled in the body. These slots should be milled somewhat shallower at the end toward the shank than at the cutting end, and they should also be wider at the bottom than at the top in order to hold the blades from being drawn from their seating. The side of the slot corresponding to the cutting edge of blade should be radial—on a line with the center—or slightly ahead of the center, according to the custom in the individual shop. For milling the slot wider at the bottom we may use a cutter slightly narrower than the desired width of the slot at the top.

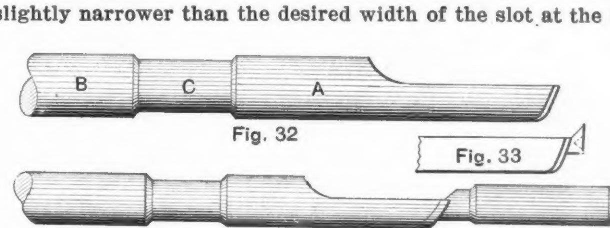


Fig. 32

Fig. 33

Fig. 34

Set this cutter to bring the face of blade in proper location and the desired depth, mill all the slots, then turn the index spindle the necessary amount to give the proper angle on side of slot corresponding to the back of tooth, as shown in Fig. 36. As stated, the slots should be less deep at the end toward shank than at the front end. This may be easily accomplished by lowering the index head spindle sufficiently to produce the desired result.

The blades are machined to shape and hardened; they are then driven to place and ground to size. The clearance is given the same as a solid reamer of the same class. A reamer need not be made of as high carbon steel as tools whose cutting edges are heavier, as the water has free access to the surfaces and the portions not being very heavy, harden very readily. On the other hand, while it is advisable to use a steel of a percentage of carbon especially adapted to the class of tool being made, in shops where detail is closely followed and

where the hardener is sufficiently versed in the proper method of treatment for each grade of steel, yet in the average shop this would lead to endless confusion. For this reason it is best as a rule to select some certain make and grade of steel and use it for as great a proportion of the tools as is possible. Probably the most satisfactory percentage of carbon, when almost any of the leading makes of steel is used, is that containing 1¼ per cent. of carbon.

Adjustable Reamers.—When it is desired to ream holes to varying sizes, regardless of interchangeability, reamers are used which can be adjusted to the desired size. In most shops they are a source of endless annoyance, because they are never adjusted to the proper size when found, and in nine cases out of ten a man will ream a hole too large before he succeeds in setting it right. However, they have their uses and in many shops are indispensable.

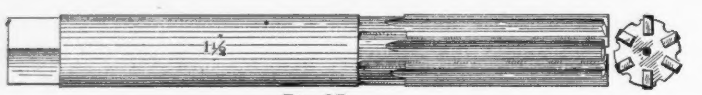


Fig. 35

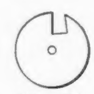
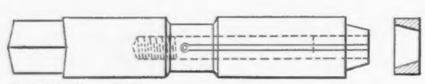


Fig. 36



Industrial Press, N.Y.

Fig. 37

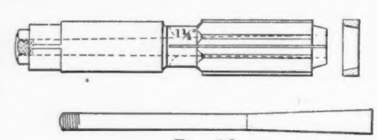


Fig. 38

There are many forms of the commercial reamer, but as most of these require special machinery and tools for their manufacture we will simply consider the most common form—shown in Figs. 37 and 38—which differ from each other simply in the form of the expander.

For making this form of reamer select stock from 1-16 to ⅛ inch larger than finish size. After the ends have been squared to length, the piece of steel should be turned straight and true to a size at least 1-32 inch larger than finish. When drilling the end as in Fig. 37, to receive the expanding screw, the outer end should be run in the back rest while the opposite end should be so strapped against the live center of the lathe that there will be no strain sideways to draw one side of the countersunk hole away from the center. In other words, it should be drawn back squarely against the live center, which should run true. The outer end may now be drilled and reamed to the proper taper. Care should be exercised when doing work of this character that the drill is started true and that it does not run. When it is exceedingly important that the drilled hole be concentric with the outside of the piece, drill a hole ¼ inch or so deep, with a drill 1-32 inch smaller than the size we desire, then with an inside turning tool bore the hole to a size to permit the drill we intend using to enter this hole. It should be a nice fit in the bored hole. There will be very little danger of the drill running, unless it is too thick at the point, in which case it should be "wheeled out" to bring the point to the proper thickness, so that it can cut properly. A drill which is too thick at the point never does good work unless a small drill is run in ahead of it. After drilling, tapping and reaming with a taper reamer the end of the hole should be chamfered to the same angle as the lathe center (60 degrees) to provide a bearing on the center when turning and grinding to size. If this chamfering is done with a tool held fast in the toolpost it will be true with the outside surface which is running in the back rest.

After removing from the back rest the reamer may be turned to a size .010 to .015 inch larger than finish, the wrench end milled square, the teeth cut and the reamer split to allow it to expand. When splitting, use a metal-slitting saw the thickness of which will depend on the size of the reamer. A small reamer requires a thin saw; a large reamer, a thicker one. The splitting should not extend quite far enough toward the end to part the stock and a thin partition should be left until after hardening, to prevent the reamer springing out of shape. This partition may be removed after the reamer is ground, by means of a small, thin emery wheel, or a beveled wheel. A serious mistake when making articles that are split after the fashion of the reamer under consideration, is to carry the saw cut to the end and entirely sever at this point. This leaves the different portions free to go where they please when hardened, thereby occasioning much annoyance, and sometimes rendering the article unfit for use. When hardening, the reamer should be dipped in the bath with the cutting end uppermost, to do away with any tendency for the piece to crack where the narrow partition is holding it.

If the reamer is made as shown in Fig. 38 the above instructions hold good except that it must be reversed in the lathe and the hole for the expanding rod drilled in to meet that from the opposite end. In this case we do not tap the hole. The nut draws the expanding rod into the tapered hole.

The collar which goes on the end supports the cutting edges by drawing them onto the expanding rod, and preventing their opening when in use.

This form of reamer is open to the objection that the cutting end is slightly larger than the balance of the tool; but when the reamer is only expanded a limited amount this objection is not serious in the case of such work as this class of reamer is used on. When it is necessary to have a reamer that will expand uniformly its entire length, it is made with inserted blades which are adjusted by means of a nut at each end, the blade being held in slots which are cut deepest at the cutting end of the reamer.

* * *

EXPORTS OF MACHINERY.

Machinery forms by far the most important feature in our exports of iron and steel manufactures. Statistics upon these products are divided into groups, such as locomotive engines, stationary engines, fire engines, electrical machinery, sewing machines, typewriters, shoe machinery, cash registers, laundry machinery, printing presses, and pumping machinery, are shown in that manner. Aside from these, however, is a great group of machinery which is not stated in separate items, owing to its variety and the large number of different classes of machinery included. This single group of "machinery not separately classified" grew from 10 million dollars in 1892 to over 20 millions in 1902. The next largest item under general classification of machinery is electrical machinery, which was only separately classified in 1898, amounting in that year to 2 million dollars, and in 1902 to nearly 5½ millions. Sewing machines, which amounted to 2¼ millions in 1889, were over 4 millions in 1902. Typewriters, which were only separately stated in 1897, amounted in that year to less than 1½ million dollars, and in 1902 to nearly 3½ millions. Locomotive engines increased from 1¾ millions in 1892 to over 5½ millions in 1900, but owing to the very great demand of the home market upon the manufacturers of the United States, fell to 3¼ millions in 1902. Metal-working machinery, which was not separately stated prior to 1898, grew from 4½ millions in that year to over 7 million dollars in 1900; pumps and pumping machinery is next in order in the class (machinery), a little over 2 million dollars; cash registers grew from $813,000 in 1900, the first year in which they were separately stated, to $1,144,062 in 1902, the other classes of machinery ranging downward in their relative order of magnitude, shoe machinery, printing presses, stationary engines, laundry machinery, and fire engines. Thus machinery alone formed in 1900 55 million dollars' worth of the exports of iron and steel manufactures out of a grand total of $121,913,548 of iron and steel manufactures exported in that year, or nearly one-half of the total. This statement of "machinery" does not include agricultural implements, bicycles, telegraph and telephone instruments, or other articles not exclusively or chiefly of iron and steel. Adding only those items of machinery included under iron and steel manufactures, it may be said that the exportations from the United States of machinery as a group amounts to about $75,000,000 annually. Next in order after machinery is the group: locks, hinges, and other builders' hardware, amounting to 6 million dollars; wire, over 5 millions; pipes and fittings, 5 millions; steel rails, nearly 5 millions; tools, 3½ millions; structural iron and steel, 3 millions; boilers and parts of engines, nearly 2 millions; castings, 1½ millions; and other articles ranging downward in their relative value.

MACHINE SHOP EQUIPMENT.—6.

EQUIPMENT OF THE FORGE SHOP.

OSCAR E. PERRIGO.

It is undoubtedly true that since the very general introduction of turret lathes, forming lathes, and the large variety of similar machines now in use in almost every machine shop making any pretense to modern equipment and up-to-date methods of doing work, the forge shop has lost considerable of its importance as one of the indispensable departments upon which the machinist of former times very largely depended for much of his material for the better classes of work. The introduction of steel castings, malleable iron castings and other similar materials, superseding in many cases the old-time forgings, has also been an important factor in the same direction, and has decreased the cost of materials of complicated form, and at the same time provided the machinist with materials which have admirably answered the purpose as to strength, and lessened the amount of machining necessary for their practical use.

And yet, while the forge shop may have decreased in the matter of importance in the making of forgings, there will always remain the demand of the machine shop for a certain amount of strictly machine forgings of iron and steel which cannot be met by any other material. Many great and important advances have been made in forging by use of improved hammers, by dies in connection with them, and by the process of drop forging, yet there is a large demand for forgings requiring the services of the skilled machine forger with his expertness in hand forging, as well as his technical knowledge of handling steel of various qualities, his expert knowledge of how to produce forgings of complicated and intricate forms, and the thousand and one conditions and requirements demanded in successfully bringing out such work, correct in form and structure, and within a reasonable cost.

In the matter of casehardening and tempering the forge shop department has increased materially, as there has never been a time in the past when hardened and ground steel work has been as much used in the better qualities of machine construction as at present; and casehardening has reached such an extent that it is rare to find nuts, cap screws and the like on any well-constructed machine that are not protected from injury by this valuable process. While the actual forging work of the forge shop has decreased its scope, it has in a general way much increased in volume, since it is now customary to add to its equipment several machine tools, such as cutting-off machines, forge lathes, heavy turret lathes, cold saws, power hack saws, and other similar machines for roughing out work, which in many instances can be much more economically done by these methods than by confining the operations to forging under the hammer. In this case the appropriate machines for these purposes are included in the equipment of the forge shop and located as will be presently described, and as shown on the plan in Fig. 1.

The foundry floor, the engine foundation, and many of the foundations for machines in the machine shop, should be kept as free from jar and from shocks sufficiently strong to disturb the ground by vibrations, as possible. For this reason the forge shop is placed as far from these buildings as may be convenient; therefore, in the rear corner of the plant, and opposite the rear end of the machine shop. The spur track from the railroad, which supplies shipping facilities and brings to the plant the raw materials necessary for its use, runs across the rear end of the group of buildings, in the rear of the machine shop and storehouse. It continues in a curve around the rear corner and up the side to the foundry gate, rising as it goes, to a height sufficient for conveniently dumping coal, coke, molding sand, etc., into the storage sheds located along that side, the first of which is shown at the left of the forge shop in Fig. 1. The curve of the railroad track cuts off somewhat of this rear corner of the building space and therefore the forge shop is located far enough from the rear line to accommodate it, and the space so left is utilized for a one-story building containing a space for the forge coal, another for bar stock storage, and the wash room and water closets.

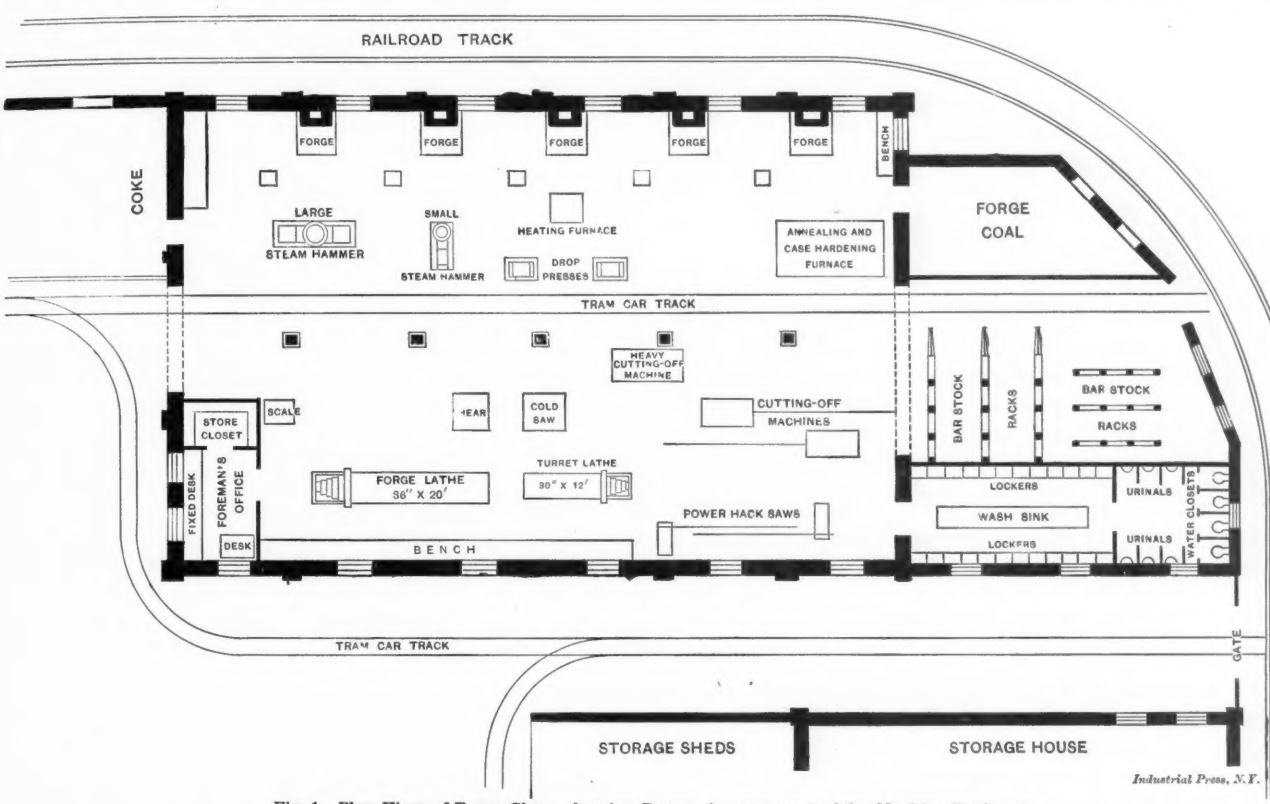
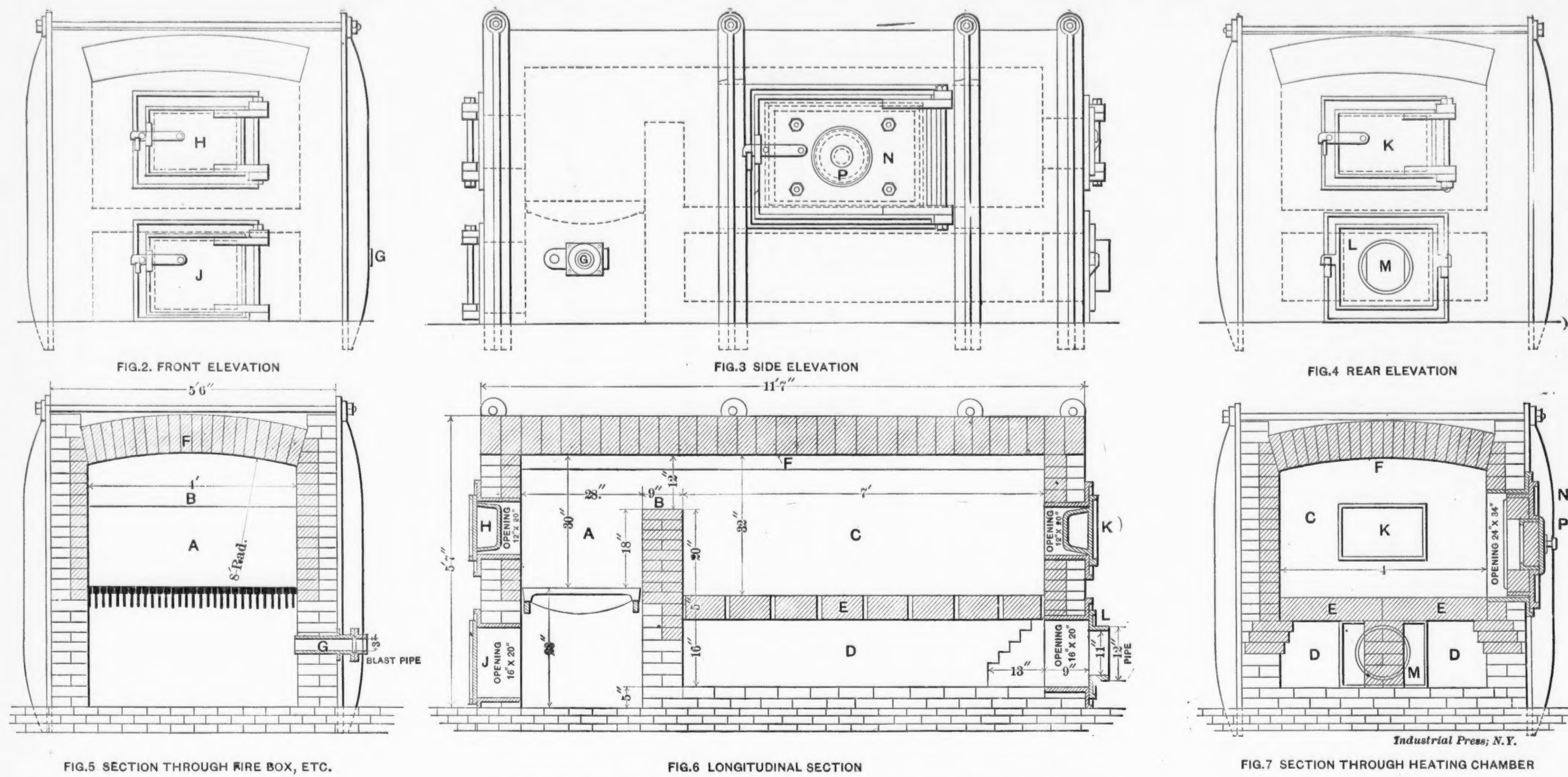


Fig. 1. Plan View of Forge Shop, showing Proper Arrangement of the Machine Tools, etc.

The forge shop is, like the other buildings of the plant, built of brick, with steel roof construction, the roof trusses being supported in the center by steel columns. It is lighted, not only from the side windows, but from those in the monitor roof, the sashes of which are hung on pivots and controlled by cords reaching nearly to the floor, by which they may be operated when necessary for ventilation. The general plan of the forge shop is clearly shown in Fig. 1, which also shows the contiguous buildings and their positions in reference to the forge shop, as well as the location of the railroad track and the tram car tracks connecting this department with the railroad tracks in the rear and the other departments toward the front of the plant. For convenience in bringing in stock and taking out finished work the tram car tracks run nearly



Figs. 2 to 7. Elevation and Cross-sectional Views of Annealing and Casehardening Furnace.

midway through the forge shop, as shown, and are connected by their branches with the foundry, the machine shop, storage sheds, and practically all departments of the plant, as well as at three points with the railroad track, two of these being shown on the plan.

The foreman's office is located in the front corner of the shop, and has connected with it the usual foreman's store closet for such minor supplies as are more conveniently kept there than in the general store room near the offices. A fixed desk furnishes a convenient place for spreading out drawings, and a private desk is provided for the foreman's personal use. Outside of the office is a forge shop scale for weighing stock and forgings. This scale should be mounted on wheels so that it can be readily moved to any part of the shop where it may be needed.

Along the outer wall of the shop are located five regular forge fires having chimney flues built into the wall for their accommodation. These latter will not be necessary if the system of down-draft forges is used. This form of forge has several good qualities, not the least of which is that it offers less obstruction in handling large pieces of work, as it may be conveniently placed at a distance from the wall if desired, and will furnish quite as good ventilating facilities in clearing the shop of coal gas as those connected with separate chimneys. The draft may be increased or decreased at the will of the operator, particularly in the case of forges manufactured by the Buffalo Forge Company, in which a hinged and adjustable hood may be closed down over a fresh fire and raised for the handling of the work to be heated, as may be desired. If these down-draft forges are used it will be necessary to provide an exhaust fan with the proper connecting pipes for carrying off the smoke and gases, which may be delivered to one chimney, thus avoiding the expense

of building the other four. Such an arrangement is very clean and wholesome for the workmen, when compared with the method shown, but considerably more expensive in its first cost, as well as requiring extra power to operate it.

The forges shown on the plan should be of such construction that the tuyeres may be readily attached and detached when necessary, for cleaning or for repairs. They should have such a form of bottom valve or gate as to readily discharge the clinkers or slag that may find its way down to it. These forges are usually constructed of cast iron and supported upon four legs, so as to give convenient access beneath them for cleaning, attaching the blast pipe, repairing, etc. Each should have, cast with it, or attached to it, two narrow troughs, running the length of its front, or shortest side, for holding coal and water. Many excellent ones are in the market and can be purchased more economically than they can be built on the premises. The blast pipe should be arranged to slide on and off easily, in case it is necessary to disconnect it for cleaning or repairs, and it should be provided with a regulating valve or gate, fitting as nearly air-tight as may be, and operated by a lever conveniently located within the reach of the operator. These forges are usually made of rectangular form, but large fires are often made upon a circular forge, whose sides extend to the floor. They need not necessarily be provided with the water and coal troughs as mentioned above, as they are usually used for heating work for the steam hammers, drop presses and similar large work, rather than for tempering, tool forging or small work of this class.

The blast for these forges, for the heating furnace for the drop presses, and for the casehardening and annealing furnace, is furnished by a fan blower designed for a pressure necessary for forge work, and having an outlet of six inches in diameter, equivalent to a No. 3 Sturtevant steel pressure blower, which is admirably adapted for this purpose. It should be located over the bench near the forges, at the front end of the shop, so that there may be no unnecessary turns or bends in the pipe leading to the forges. These pipes should be placed along the walls near the floor, but never beneath it. In one shop the writer saw blast pipes, composed of vitrified drain tiles, the joints made with Portland cement, and laid less than a foot beneath the surface of a dirt floor of the forge shop, and at one point passing directly under a bolt header. As might have been expected, the jar of the shop floor broke up the pipes and destroyed their usefulness. The blast pipes should be constructed of heavy galvanized iron, well fitted and fastened, and as nearly air-tight as may be. They should be easy of access, for the possible connection of additional pipes and for convenience of making repairs, which will have to be made sooner or later. They might be placed six or seven feet high, and along the walls, but this position will necessitate about thirty feet of additional pipe, increasing the friction of the air and consequently the power required, with no especially compensating gains other than getting the pipes up, out of the way somewhat.

Some of the more important rules for setting up and connecting forge blowers may be here given. Place the blower as near as possible to the forges. Make the pipe connections as direct as possible. If bends or elbows are absolutely necessary, make the curves of large radius, and with no abrupt angles; the inside radius of an elbow should not be less than twice the diameter of the pipe. Have the aggregate areas of all the outlet pipes at least equal to the delivery pipe at the blower. If the pipes must carry the air over one hundred feet, speed up the blower proportionately above the figures given in the manufacturers' catalogue. In any event, the blower should be run at such a speed as will give four to five ounces pressure at the tuyeres, not less than four ounces at the forge furthest from the blower.

The blower is driven from a line shaft running the length of the shop near its center. In front of the first fire is located a large steam hammer of the arched pattern, and capable of handling work up to ten inches in diameter. At the next fire is a smaller, single-column steam hammer of about half the capacity. The necessity of providing the larger hammer will be a matter to be decided by the size of the largest forgings to be made. For instance, if only a few forgings which come up to its capacity are to be made, it will be more economical to purchase them of some large forge shop than to provide a large hammer that may be idle much of the time. The smaller hammer should be provided for even moderate-sized work, for any plant of modern pretensions.

Next to the small hammer two drop presses are located, with a special heating furnace for use in connection with them. These drops should carry hammers weighing from one hundred and fifty to six hundred pounds, according to the work which they are to do.

The heating furnace need not be over thirty inches square outside, built with a cast-iron shell lined with fire bricks, supported on four cast-iron legs, and provided with a vertical sliding, balanced door in front. The heating chamber will be about twenty inches square and from ten to twelve inches high. A blast pipe leads up to it, and a smoke pipe from its rear side leads to the nearest chimney. Such a furnace will heat work for drop forging much more economically and satisfactorily than the usual open forge fire. They may be purchased at a very moderate cost.

The forge fires not occupied with steam hammer work will be used for ordinary hand forging, tool forging, tool dressing, tempering, and similar work. Where much tempering of special work is necessary, that is, when a large number of pieces of the regular product of the plant is to be so treated, special arrangements as to heating furnaces, dipping baths, etc., must be provided, and in many cases special automatic heating and hardening furnaces are employed. Obviously, the great variety of this class of work precludes a detailed description in this article.

Near the end wall, at the rear, is located an annealing and casehardening furnace of ample capacity. As this will be built on the premises, and as information in reference to its requirements and its construction may not be readily available, drawings have been made showing the details of its construction and giving all necessary dimensions. While this is for a furnace of quite large capacity for a machine shop plant, a smaller one may be readily constructed on proportionate dimensions, with good and practical results. If it is to be of, say, one-half these dimensions, or one-fourth the capacity, the lower heating ducts will be single instead of double, and it will be preferable to build it with a cast-iron casing inclosing all four sides, forming the door frames, and the separate pieces being bolted together at the corners, instead of having the brickwork held together by binders and rods as shown in the drawings.

The construction is clearly shown in Figs. 2, 3 and 4, being respectively a front, side and a rear elevation. Fig. 5 is a cross-section through the firebox *A*, showing the bridge wall *B*, the form of the covering arch *F*, and the position of the blast pipe *G*. Fig. 6 is a longitudinal section showing the firebox *A*, heating chamber *C*, heating ducts *D*, *D*, and sections of the front and rear doors. Fig 7 is a cross-section through the heating chamber *C*, the heating ducts *D*, *D*, dividing wall *M*, and the main door *N*. The foundation should be laid deep enough to support the weight of the furnace and its charge, and will be quite similar to that provided for boiler settings. The shaded portions indicate fire bricks, the balance being ordinary, hard, red bricks. The grate bars are of any convenient pattern, but must have ample air spaces so as not to impede the air blast delivered through the blast pipe *G*. The top arch is of fire brick and is carried all the way through both front and back walls, for convenience in making repairs upon it. The floor of the heating chamber is composed of fire brick tiles five inches thick, nine inches wide and twenty-four inches long, their outer ends supported by the inwardly projecting side walls, and their inner ends by the dividing wall *M*. They are laid about an inch apart so as to permit the gases and smoke to pass down between them to the heating ducts *D*, *D*, and out through the smoke pipe attached to the rear door *L*. The frame and door of the firebox are from the same pattern as the rear door *K*, while the frame of the ash pit door *J*, and the smoke door *L*, are from the same pattern. The doors are different, of course, as the door *L* must be provided with a circular sleeve to which the

smoke pipe is attached, its other end connecting with the nearest chimney. The main door N, through which the annealing boxes are introduced, and removed, is of special construction and fitted with a fire brick lining, perforated by a circular opening or "peek hole," and held in place by four bolts (as shown in Fig. 3), which pass through iron straps on the inside of the fire brick lining. The stopper P is of tubular form and has an inwardly-projecting flange at its inner end for the purpose of holding the lining, which is composed of fire clay packed in as solidly as possible while it is slightly wet. This stopper may be removed at any time to obtain a view of the interior of the heating chamber and its contents during a heat, as all the doors are tightly closed and the cracks fluted with fire clay as soon as the fire is well under way, one charge of coal being usually sufficient for the heat after the furnace has been heated up.

The blast pipe furnishing the blast for the forges will also supply this furnace, the pressure required being the same, and will be connected to the fixture G located in the wall of the ash pit for that purpose.

Such a furnace as has just been described will, if properly built, and with occasional repairs to the fire brick lining, last many years. The writer knows of one which was built twenty years ago that is in serviceable condition at the present time.

On the opposite side of the central columns is located the group of machines for roughing out stock, the first being a heavy cutting-off machine capable of taking in stock up to six inches in diameter and cutting it off to any required length. In this machine there should be two tools fed automatically, and the machine should be provided with a convenient speed changing device whereby the surface cutting speed may be maintained constant at all diameters, as this latter feature will materially increase the output of the machine.

Next to this machine are two cutting-off machines of a capacity for four-inch stock and arranged similarly to the larger machine. They are so placed as to be conveniently operated by one man.

Next to these machines are two power hack saws, provided for cutting off square and flat stock. These should carry from twelve to fifteen-inch saws, and while apparently slow-working machines, are capable of cutting off a large quantity of stock in proportion to the labor cost of attendance.

Located near the large cutting-off machine is the cold saw, which will serve for stock or forgings beyond the capacity of the cutting-off machine or the power hack saws, and will often save much valuable time in finishing up a forging. The saws in these machines are from twelve to forty inches in diameter, the former size cutting off stock up to three and a half inches in diameter, and the latter handling thirteen-inch stock. For this case the saw should be twenty inches in diameter, and capable of cutting off seven and a half inch stock. There are many of these saws in the market and apparently not very much choice between them, all conditions being considered.

The shear, located next to the cold saw is not generally as much used as before the power hack saw came into notice, yet in certain classes of rough work it is very useful and operates quickly. It should be able to cut off round stock up to one inch, square stock to the same size, and flat stock to a half inch by two.

In the heavy turret lathe much work may be roughed out from the bar and sent to the machine shop in a more satisfactory condition than if it had been forged, and at the same time it will do the work more economically. It should take in stock up to three inches in diameter and be provided with a heavy, open, hexagonal turret, bored so as to allow the stock to pass entirely through it if necessary. It should also be provided with heavy roughing tools somewhat similar to box tools, as well as a heavy cutting-off slide adjustably supported on the bed.

The forge lathe, located next to the turret lathe, will be useful in rough-turning spindles and similar heavy work, and doing it much cheaper than forging the work down to close dimensions. It should be built for cuts of six or eight to the inch, and a cutting speed from one hundred feet per minute and slower.

A short work bench and vise is provided at each end of the line of forges for the convenience of the blacksmiths, and a much longer one on the opposite side for the men running the machine tools, which should have three vises upon it.

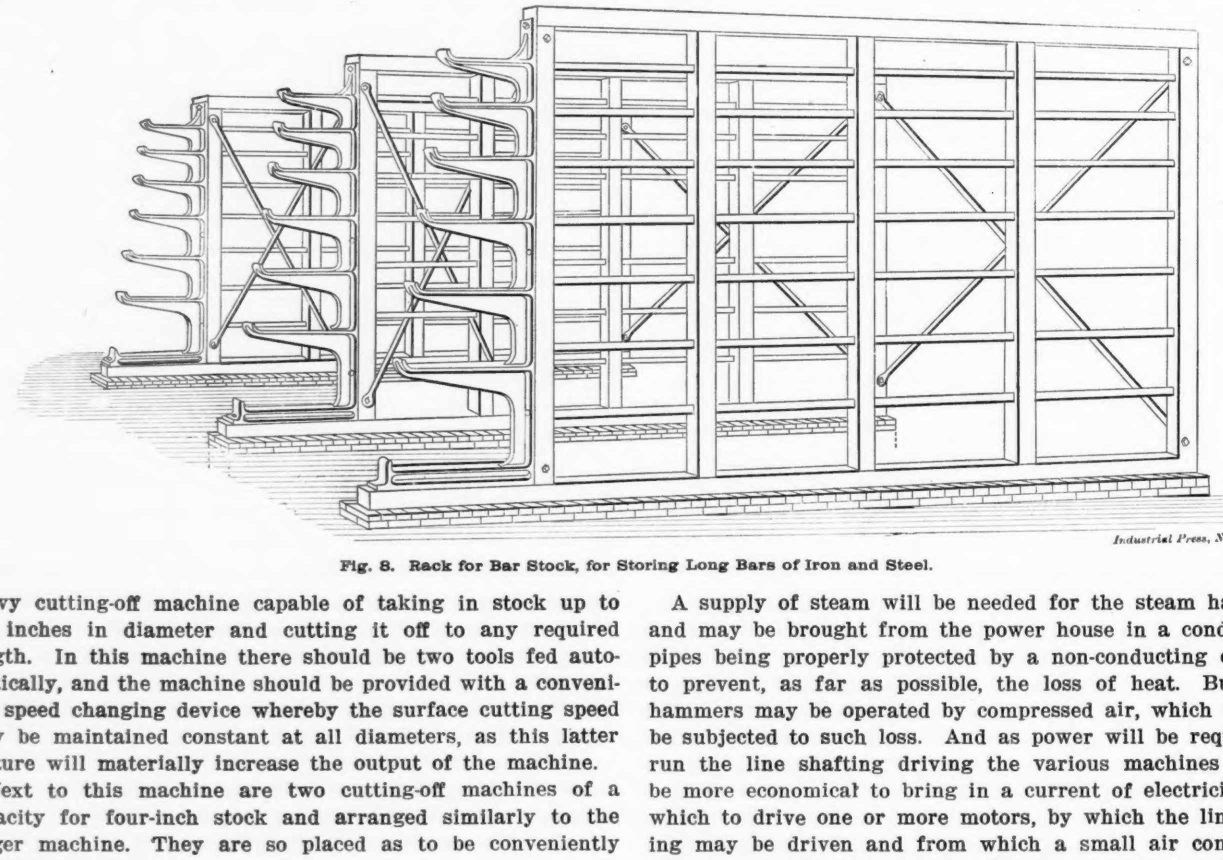


Fig. 8. Rack for Bar Stock, for Storing Long Bars of Iron and Steel.

A supply of steam will be needed for the steam hammers, and may be brought from the power house in a conduit, the pipes being properly protected by a non-conducting covering to prevent, as far as possible, the loss of heat. But these hammers may be operated by compressed air, which will not be subjected to such loss. And as power will be required to run the line shafting driving the various machines it may be more economical to bring in a current of electricity with which to drive one or more motors, by which the line shafting may be driven and from which a small air compressor may be operated, thus bringing the power within the building and under the control of the foreman in charge of it. This plan would seem more advisable than the other. If an air compressor is used it may be located between the shear and the scale, and the reservoir connected with it placed directly overhead.

If an electric motor is used to drive the line shaft it will be convenient to place it overhead and near the center of the shaft, on a platform erected for the purpose, rather than to place it on the floor level, where it will be subjected to dirt and accidental injury.

A jib crane may be erected to serve the large steam hammer and an overhead trolley for the smaller one, the latter being the more economical of the two, and will be found nearly as convenient for comparatively light weights. The I-beams carrying the trolley and hoist should run from a point nearly over the center of the forge to a point close to the left side of the hammer, as seen on the plan.

Pneumatic hoists may be conveniently used not only on this trolley but in a similar way at the forge lathe and over some of the other machines for handling heavy bars. They work quickly, are easily handled, and when necessary may be readily moved from place to place.

The space for bar stock is located conveniently to the railroad track and the tram car track, and contains two racks for bar stock, the larger one for full length bars of iron and machine steel, and the smaller one for ordinary cast steel and tool steel bars. The larger of these racks is shown in perspective in Fig. 8. This is constructed of oak timbers formed into a rectangular frame, strongly bolted together and resting on good foundations capable of supporting the heavy weights of stock likely to be placed in the racks. Three of these frames are erected, six or seven feet apart and braced by cross-braces as shown. The timbers should be six inches square and provided with iron supports for the bar stock. These should be spaced further apart at the bottom than at the top, the bottom space being, say, fifteen inches, and the top space eight inches, center to center of cross bars. These supports should be flat, say, five-eighths by one and a half inch for the upper three; for the next two, three-quarters by one and three-quarters; and the two lower ones, one inch by two. It may be preferred to make the three or four lower supports of one and three-eighths-inch round steel, upon which are placed pieces of one and a half-inch gas pipe, turning freely, and so facilitating the running in and out of heavy bars. As seen in the engraving, the right-hand end of the frames may be securely bolted to the brick walls, and the cross-braces on this end be omitted. At the opposite, or front end of the frames, the sill timber projects from the front of the frame about three feet, and upon this are erected heavy cast-iron supports, of the form shown, which will be found very convenient for holding heavy bars, as they are open at the front, and bars may be readily lifted from the tram cars to them. Experience has shown this to be a very convenient, useful and substantial form of bar stock rack. In place of wooden timbers cast-iron supports may be used, but the cost will be much greater and the results not enough better to compensate for the added expense.

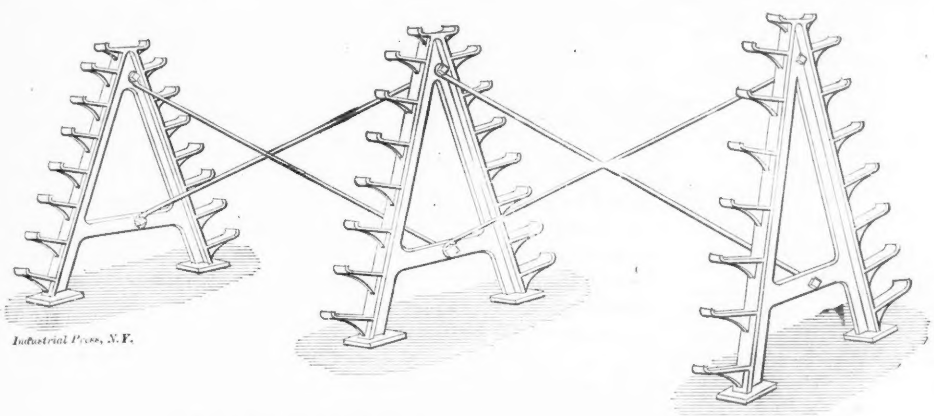


Fig. 9. Small Rack for Ordinary Cast-steel and Tool-steel Bars.

The smaller rack is built on the same plan, and may be constructed with or without the cast-iron racks in front of it. It should have substantial cross-braces between its frames, and also be securely braced from the brick wall.

For a shop rack the form shown in Fig. 9 will be found very convenient. The A-shaped supports are of cast iron, securely braced by cross-braces bolted on as shown. The base of the supports might be made relatively narrower than shown in the drawing without endangering their stability. Such a rack may be made of any number of supports and placed at any desired intervals apart that the work may require. Once we have the pattern, we may make as many castings as we choose and arrange them to suit any existing conditions. Usually they should not be over five feet high, unless rather small and light stock is to be placed on the upper supports. The lower projecting supports may be about ten inches long and the top ones about seven inches.

The wash room is located in one of the rear corners, and in connection with the water closets, which open out of it. A single wash sink of similar construction to the one illustrated and described in the article on foundry equipment is provided, and the individual lockers for the use of the men, and built of expanded metal, are arranged on both sides of the room in the usual manner. In the water closets six urinals and four closet seats are provided, the latter protected by double-hinged swinging doors, and the former separated by dividing partitions two feet wide. Both should be provided with an ample supply of water for automatically flushing them. The windows lighting the wash room and water closets are placed high enough in the wall so as not to interfere with the lockers or the urinals.

By the plans herein given all of the requirements of the operatives are placed conveniently within the building, so that whether for stock, fuel, or any reasonable cause, there is no necessity of leaving the building, as it is a well-known fact that men working near artificial heat, as do those at forges, are very sensitive to both heat and cold out of doors.

* * *

DURANGO'S IRON MOUNTAIN.

This solid mass of iron ore, close to the International Railroad depot at Durango, has figured in story and fable ever since the Spaniards and the Mexicans from the south first reclaimed this region from savages akin to the Apaches, over three hundred years ago. Geologically, examination shows it to be a very remarkable "dike," emerging from a rocky plain at the elevation of 6,300 feet, rising from 400 to 650 feet in height itself and forming a tremendous lump of iron ore 1 mile long and one-third of a mile wide. It has been calculated to contain 500,000,000 to 660,000,000 gross tons above the surface, with no notion of what may be below. The ore is a hard specular hematite, carrying on an average 60 per cent. of metallic iron, much of it going higher and some even to 67 per cent. It is suitable for practically all processes of iron and steel making.

One might think that such a property as this, where "mining" consists simply in knocking down the sides of a mountain to obtain a rich iron ore, in a country whose industrial expansion is demanding larger and larger importations of iron and steel, would be better than the best proverbial bonanza of gold. The fact is, however, that the Mexican National Iron and Steel Company, an American concern, whose mining claims cover about one-half the mountain, has never until lately been a paying concern. This seems to have been due, first, to the fact that it was formerly operated with a view solely or primarily to sale of stocks, and, in the second place, to the difficulties in securing at a reasonable price fuel with which to operate it on a paying basis. Charcoal can be obtained near here, made from the timber on the Sierras to the westward, but its production has always been limited and relatively expensive. Coke was formerly brought from the United States and at such prices that the marketing of the company's iron products in Mexico, except at near-by points, was, when the high freight rates were added, very commonly at a loss, or no gain, in competition with American iron products. As stated, Mexican coke is now obtained and at considerably lower prices. Moreover, the concern is being managed primarily as a business enterprise. Facilities are being added for an increased output, and everything augurs great prosperity for this institution, which now turns out in its foundry and machine shops steam engines, hoisting machinery for mines, stoves, and simpler products, such as nails, as well as bar iron. The steel plant, which the company's name implies, may soon be added.—*Consular Report, No. 1812.*

* * *

The total value of American machinery and tools imported into Switzerland during the first six months of 1903 was $107,000.

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MACHINERY

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We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

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NET CIRCULATION FOR JANUARY, 1904,—26,694 COPIES.

MACHINERY is published in three editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a complete review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering, but is printed on thin paper for transmission abroad.

SUGGESTIONS THAT HELP.

As a matter of course the editors of a technical journal receive a great many inquiries from subscribers, asking for information upon various subjects. In our own field we endeavor to give the information desired, either through the "How and Why" department, or if the subject is not of general interest, by referring the inquirer to some text-book or article which will tell him what he wants to know. We do not consider it within the province of a technical journal to devote space to matter that can easily be found in the ordinary books of reference, and thus take room that should be devoted to more timely matter of current interest.

Probably the readers of MACHINERY do not fully appreciate that such letters of inquiry are frequently of great service to the editors, in that they suggest topics for articles upon which published information is apparently lacking. A case in point is a contribution this month by Mr. Herbert E. Field, upon compositions and bronzes. A subscriber wrote us that he had tried to produce a very strong alloy by following Prof. Thurston's well-known formula of 55 per cent. copper, 42.5 per cent. zinc and 5 per cent. tin. According to Prof. Thurston a bronze of this mixture had shown under test a tensile strength of 68,000 pounds per square inch, yet our correspondent had not been able to produce a casting of over half this strength. Investigation showed that while handbooks contained statements of proportions for mixtures for alloys, nothing was said in any of them about the methods of mixing, melting and pouring to produce the best results; and it was at once evident to us that an article on this subject, telling what a man who had to make very strong bronze castings would want to know, would be of assistance to many readers, although this had not occurred to us previous to receiving the inquiry.

Another instance is a contribution in a recent number upon the coloring of metals. This was written as the direct result of an inquiry by a subscriber who could not obtain information about the best methods for producing blue, black, brown and other colors on steel, brass and copper. We found that very little had been written upon this, and that what had appeared was not fully treated, and so arranged for the article in question.

We should like to have these two instances of how subscribers have assisted us in securing interesting or valuable articles, serve as a hint to others, and accordingly ask any to write us, who are seeking information upon subjects which they believe would prove of interest to others as well as to themselves, if presented in the columns of MACHINERY. We believe we can render additional service to our readers in this way, as we have on file the names of specialists who are qualified to write authoritatively upon many branches of shop-work, machine design, and kindred topics.

Do not hesitate to send us suggestions.

* * *

IS THIS GENERAL ENGLISH PRACTICE?

The American machine tool builder who goes to Europe to introduce his product should be prepared for some surprises, agreeable and otherwise. In locomotive shops, for instance, he will very likely be impressed with the fact that in Europe locomotives are better built than in America—in a certain sense. They are highly finished, closely fitted, and generally designed for long service—how long, depends on the traditions and sentiments that eventually attach to many locomotives. But in the machine shop practice he will undoubtedly find some features not so pleasing. A gentleman, who recently visited Europe in the interest of the machine tool business, says that drilled and reamed centers in lathe work are practically unknown in many English shops. The standard taper of American lathe centers is 60 degrees; that of English lathe centers is 90 degrees (or thereabouts). As will be inferred from the foregoing, the reason for using such blunt centers is the very good one, or rather the very bad one, that all small and medium-sized work is centered with the prick-punch. The centers are *worn* into the work by heavy pressure applied on the tailstock. In fact the common practice is to put the work between the centers and screw up *hard* on the tailstock spindle for a few moments with the work revolving; then reverse the work and treat the opposite end in the same manner. Of course no 60-degree center will stand such treatment. And the 90-degree centers are found there worn into all kinds of fantastic shapes, approximating the Schiele curve, so-called.

The foregoing, relative to lathe centers, has a serious commercial aspect to the American machine tool builder when it is found to interfere with the production of accurate work. From one English shop in which a universal grinding machine had been installed, a complaint was sent that the machine did not grind work with the accuracy guaranteed by the makers. Investigation showed that the prick-punch method of centering was also being used on the grinding machine work! The suggestion was gently made that the centers should be nicely drilled and reamed to an angle of 60 degrees to fit the centers on the machine. Objection was raised that the shop had no facilities for doing this, but after some argument some Slocomb combination center drills were produced, though the proprietor insisted that they had never been able to make the "American gimcrack" work satisfactorily—that they invariably broke before the center was reamed to the proper depth. Further investigation along the line revealed that the spindle of the machine used for the purpose ran at only about 80 revolutions per minute. It was pointed out that it should run fully twenty times as fast, and when this change was made the troubles of center reaming and grinding were cured.

* * *

One of the surprising experiences of the writer has been that of visiting the plant of an old, well-known manufacturing concern and finding in what an out-of-the-way place it is located. Not as regards the town, but the site of the works—down in a narrow gorge, exposed to damage by floods and remote from the railway so that all supplies and product have to be hauled, at heavy expense, by teams. The reason for such a location, of course, is not far to seek; it was the water power, and in early years cheap power meant a great commercial advantage, perhaps more than now for many industries. Thanks to electrical transmission of power all these water powers can be made useful without placing the actual location of the plant where it is difficult to get at; it may now, in most cases, at once enjoy the commercial advantages of water power and convenient location to lines of travel. This condition is recognized to the extent that old water powers which had fallen into

disuse, are being resurrected and made to turn the wheels of industry miles away. In a paper "The Influence of Electricity on the Development of Water Powers," read before the last semi-annual meeting of the New England Cotton Manufacturers' Association by Mr. F. A. C. Perrine, attention is called to this changed condition of affairs as regards water power for cotton mills. Mr. Perrine, however, expresses the belief that as a general proposition it does not pay to develop a water power where the first cost exceeds $300 per horse power for continuous power, and $200 for variable power, which makes the installation of a steam plant necessary for slack water periods.

* * *

THE DANGEROUS AUTOMOBILE.

That automobiles, or rather those racing machines which are the outgrowth of speed madness, can be built to run at great speed—equal to that of the locomotive even, has been quite amply demonstrated during the past year or two—quite too well in fact for the peace of mind and physical well-being of other road users. The latest exploit is that of whom the New York *Times* is pleased to call "a young speed maniac," who succeeded in covering one mile in 39.4 seconds on the ice of Lake St. Clair near Detroit, Mich. The ice was cleared of snow for a distance of five miles in a straightaway course. Hot cinders and sand were then spread on the course to a depth of one-half inch. This was cleared off as much as possible before the test was made. Notwithstanding the almost ideal conditions for fast speed the run was attended with great excitement and hazard for the chauffeur. What the mortality would have been if the course had been a country road lined with spectators it would not be pleasant to contemplate. The *Times* concludes an editorial comment with the following scathing arraignment of high speed machines in general:

"Machines capable of a fraction of the speed attained at Detroit should be subject to indictment as public nuisances even when standing in the shed. They are to be classed with infernal machines, spring guns, mantraps, and other things in which reside the potentialities of manslaughter and homicide. Their manufacture promotes the end of the industry, by making necessary the enactment of even more stringent legislation than has yet been seriously proposed as the alternative of a recourse on the part of the public to summary measures of self-defense. It would be entirely proper, in the light of experience, to make the possession of a machine capable of materially exceeding the legal speed limit an offense of the kind committed in the carrying of concealed deadly weapons. To own a kit of burglar's tools is a crime, even though the owner cannot be shown to have used them burglariously. To carry hidden weapons is a misdemeanor, even though the possessor is to all appearance peaceably inclined. An automobile which can be run at dangerous speed sooner or later will be so run. If its owner has too much self-respect or respect for others to abuse it, some servant will do this the moment his back is turned. There is something in human nature which cannot resist the temptation to go fast when the means are at hand; and, curiously, those want to go fastest whose time is worth least."

* * *

THE DATA SHEET FOR FEBRUARY.

The data sheet for this month is planned to be of assistance to the designer in computing the weights of parts and for general estimating purposes. The first table presents a diagram of the weight of sheet metal for different thicknesses, both in metric and English measurements. In this country and in Europe thousands of tons of metal are sold annually by the weight per square foot, as this is considered more convenient and reliable than any other form of measurement, since owing to the operation of the rolls it is difficult to caliper the metal accurately by the edges, as the center is often thicker. In shipbuilding particularly the metal is specified in weight in pounds per square inch. In Europe material is commonly specified by thickness in millimeters and by the weight in kilograms per square meter. This table is arranged with a view of convenience in changing from one method of measurement to any other.

On the left hand side of the diagram the weight of sheets of various metals for a given thickness is given in kilograms per square meter, while on the opposite, or right-hand side, is given the weight of the same sheets in pounds per square foot. At the top of the diagram is given a scale of the thickness of a sheet in millimeters, while at the bottom is, first, a scale of 1¼ inch in hundredths and a corresponding scale in 64ths of an inch; next a scale of the thickness in United States Standard gage, while below is the same in Birmingham wire gage. Thus the diagram not only shows at a glance the weight in pounds per square foot, or in kilograms per square meter, but it also answers as a conversion table for the weight of sheets designated in any one system of units to any other units desired.

Table 2 gives the approximate weight of cast iron gears from 12 to 144 inches in diameter and having cast teeth from 1 inch to 6 inches circular pitch. These weights are the average of over four thousand standard gears that were weighed by the compiler during a period of four years. For estimations where the exact weight is not required the results derived from this table will be found to be quite accurate enough for all ordinary purposes. The figures given are for one inch of face and, for obtaining the weight of any gear, it is only necessary to multiply the number under the required diameter and pitch by the number of inches of face.

Table 3 gives the areas, circumferences and weights of the commercial sizes of cold-rolled shafting. For the weights here given we are indebted to the Jones & Laughlins Company, Pittsburg, Pa.

Page 4 comprises four tables, the first of which gives the weight of cast iron per superficial foot for various thicknesses. The second table gives the weight of nuts and bolt heads, and will be found useful when figuring the weight of long bolts. In this case the length of bolt under the head would be figured as a bar of given diameter and length and to this result would be added the weight given in the table for the nut and head. The last table gives the weight per cubic inch and per cubic foot of nearly all of the common metals and alloys and their specific gravities.

* * *

LARGE UNIVERSAL CHUCK.

What is undoubtedly the heaviest universal chuck ever built, in this country at least, was constructed last summer at the works of the R. D. Nuttall Company, Pittsburg. The diameter of the faceplate is 132 inches and its weight is 34,600 pounds. It carries eight jaws which are operated simultaneously by a ring bevel gear containing 266 teeth 2 diametral pitch and 2½ inches face. These teeth engage the pinions on the screws, which have 14 teeth each. The gear ring also has 266 spur teeth 2 diametral pitch cut in its periphery for the spur pinion gear through which the ring and jaws are operated. The pinion gear is not mounted in the faceplate but is attached to the frame of the machine, provision being made for throwing it into gear when the jaws are opened or closed. The screws moving the jaws are 2½ inches diameter. The chuck is driven by a pinion working in an internal gear cut from the solid on the back of the faceplate. The teeth were cut by a Newton gear planer or slotter having a capacity up to 30 feet diameter. The internal gear contains 120 teeth 1 diametral pitch and 9 inches face.

* * *

HUMOR OF A STRIKE.

Two strikers were picketing the entrance of an alley during the strike at the factory of the Kellogg Switchboard and Supply Company in Chicago last May. A non-union man came out of the factory and started across the street. One of the strikers picked up a brick. As he looked at it an expression of disgust came over his face and he threw it down.

"Why didn't you throw it at that scab?" asked the other striker.

"Because it is a non-union brick."—*The World's Work.*

* * *

A simple method of finding the height of high interiors, is to use a toy balloon attached to a thread. When the balloon touches the roof or ceiling, the floor line is indicated on the thread by a knot and the length measured along a convenient horizontal plane. This method was successfully used in the measurement of the height of cavern roofs in the Mammoth Cave, Kentucky.

HIGH-SPEED TOOL STEEL TESTS.

We have received from the Lodge & Shipley Machine Tool Company, Cincinnati, O., a summary of the results of tests upon high-speed steels which have been conducted at their works. This company was one of the first to adopt the Taylor-White process for treating steels for high-speed tools and have since tried nearly every high-speed steel that has been placed upon the market. While testing one of their high-speed lathes, which was designed to meet the new conditions brought about by these new steels, the experiments referred to were made with a view to finding the relative value of the several steels offered by different dealers, what speed limit it was possible to maintain with each, what the breaking-down points were, etc. The lathe used was a Lodge and Shipley 20-inch equipped with high-speed head, tailstock and double tool rest. The spindle is exclusively gear driven with two changes of speed, the ratios from pulley to spindle being 3.1 and 9.1, secured by sliding gears operated by a handwheel in front of the headstock. The tailstock is massive, and held to

Fig. 1. Condition of Lathe Tool after Tests were Made.

the shears by four bolts running through to the top. The carriage is equipped with two plain rests, both operated by telescoping screws and the same handwheel, which has a clutch in each end of the hub to engage with either front or back rest screw, as may be desired. The front tool rest has a transverse adjustment to permit easy setting of the tools and the dividing up of the cut when necessary. The power was derived through a 6-inch belt from a No. 3 Chard variator mounted on the ceiling and belted from lineshaft. This variator gives eight changes of speed, secured instantly without stopping the lathe. With the constant shaft running at 235 revolutions per minute, 637, 506, 376, 272, 200, 146, 108 and 85 revolutions per minute were secured at the variable shaft of the variator.

Seven brands of steel were selected for tools and labeled from A to G, respectively. Several tools of each were made, all alike, and the different tools of each brand were indicated by numbers.

Limit tests were made with a 5⅛ diameter bar of machine steel containing about 0.18 per cent. carbon. Preliminary tests were made while removing scale to determine in about what order the tools might stand so as to give the better ones the higher speeds. Cuts of ⅛ depth by 1-20 feed were then made, and here tool A-2 with a cutting speed of 201 feet per minute cut a total distance of 14¼ inches without breaking down. Its nearest competitor was a tool which ran 6 inches at a speed of 180 feet per minute, the others ranging from 1½ to 5 inches at a cutting speed of about 190 feet. The bar was then turned round and a light cut taken over it at a depth of 1-32 inch by 1-40 inch feed. Tool A-2 again led, running 25 inches at a cutting speed of 361 feet per minute. The next best was a tool which ran 18 inches at a speed of 305 feet. The balance ranged from ½ inch to 6 inches.

Tests on cast-iron were then made, using a casting 8 inches in diameter and 12 inches long, clean of sand, and of about medium grade iron. After removing the scale light cut tests were run with 1-20 feed and 1-16 depth of cut, at 184 feet surface speed. Here some of the tools broke down instantly and most of the others did but little better, tool A-2 being the only one which ran across the casting, and one other ran 2⅛ inches. With a medium cut of 1-10 feed and ⅛ depth and about 1-19 surface speed most of the tools made a little better showing, although several broke down at once. Here again A-2 made a record of 15 inches. One of the B brand tools made the best showing of the balance, with two of the tools of the A brand falling in the rear but still leading the others.

The result of these tests shows that brand A, of air-hardening steel, tempered at a high heat in oil, is far superior to the others. All of the tests were run dry.

These trials were supplemented by several other endurance tests, using the two brands of steel showing the best records in the limit tests. Twenty-five back-gear sleeve forgings were selected, of about 0.18 carbon machine steel, and with from ¼ to ⅜ inch in diameter to be removed. This series was run with the tools wet, there being two tools, one in each rest, and the back tool removing only sufficient to keep under the skin of the forging most of the time. The body of the forging was 2⅞ inches diameter, with a large collar at one end and a total length of about two feet. Both tools required regrinding after finishing eight forgings, at a total of 152 feet longitudinal feed of tool at a surface speed of 169 feet. After regrinding the tools, seven pieces were finished when the back tool broke down, the front tool, however, being still in a very fair condition. They then tried a single tool, A-2, and finished nine pieces, or one more than the full run of the double tools, and found the tool still good for further use. The condition of the tool being somewhat interesting, it is shown in Fig. 1. The friction of the chip curling from the tool has worn a concave spot on top of the point, while there is no evidence of wear on the cutting edge. The outlasting of the single tool over the double, is attributed to hard spots in the forging, as in later tests on bar stock they have demonstrated a saving in the use of two tools.

Among other tests made was one upon a lot of back-gear forgings, similar to but larger than those mentioned above, in which the total time for handling and turning, by a lathe hand, unassisted, was 24 minutes, for eight forgings, or at the rate of 200 in 10 hours, although this rate could not have been maintained all day by the same man. The tool used was A brand steel, oil hardened, and was in good condition at the close of the experiment. Fig. 2 shows the forgings as rough-turned during the experiments. The larger pile contains 30 pieces rough-turned on the long end only and represents 1½ hours work had the same rate of speed been maintained for the lot as was recorded for the eight mentioned.

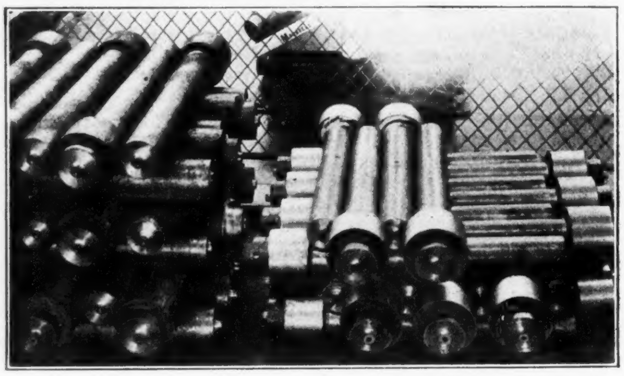


Fig. 2. Pile of Lathe Spindle Forgings Rough-turned during Experiments.

Another series of experiments were conducted to show the horse power consumed by the lathe and variator, while taking a cut at different speeds. It was quite clearly demonstrated during these tests that the higher speeds required much more power to remove a given amount of metal than the lower speeds and also that the angle of cutting edge of tool affected the power. With a depth of cut of 1-16 inch and feed of 2-15 inch about 18 horse power were required at a surface speed of 175 feet. With the same depth of cut and 1-10 inch feed about eight horse power were required, at 121 feet per minute. With depths of cut of ½ inch, feed 1-20, and speed 160 feet per minute, over 30 horse power were required, while at 128 feet only 19 horse power were necessary.

* * *

Articles of iron can be protected against iron rust by sinking them near the negative pole of an electric bath composed of ten liters of water, fifty grams of chloride of manganese and 200 grams of ammonium nitrate. Under the influence of the current the bath deposits on the articles a protecting film of metallic manganese.—*Mining World.*

THE RIEDLER-STUMPF STEAM TURBINE.*

AN IMPORTANT GERMAN WHEEL IN SUCCESSFUL USE.

"Extended study and experiment, in an entirely untried direction, having for their goal the overcoming of the many existing defects," writes Dr. Riedler, "have led Prof. Stumpf and myself to the creation of a new system of turbine construction."

The fundamental considerations were as follows:

From a purely dynamic standpoint the peripheral velocity of the wheel need be only half the velocity of the steam in order to gain the full force of the steam. This is the idea underlying De Laval's construction, which led to unserviceable rotary velocities and made the use of reducing gearing necessary. Therefore, in order to make any progress possible, while using the single or one step pressure effect and without essentially changing either the velocity of the steam or the peripheral velocity of the wheel, the following details must be technically accomplished:

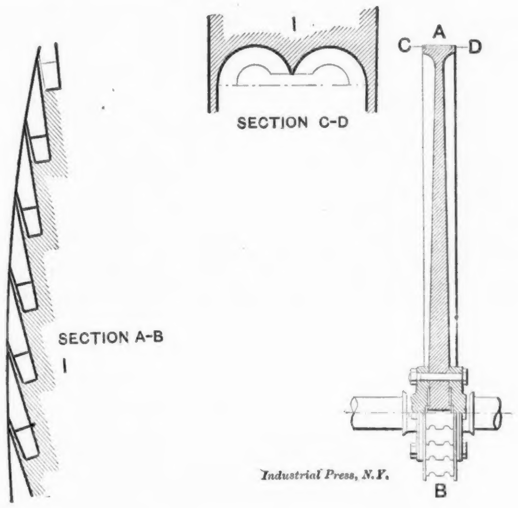


Fig. 1. Sections of Buckets.

1. When operating under the one step effect.—The diameter of the wheel should be so increased that with a practical speed of from 1500 to 3000 revolutions per minute, or just about 1-10 that of the velocity of the Laval turbine, the relative flow of the steam may be used to proper advantage.

2. By stepping down the velocity (compounding) the number of revolutions can be further reduced to 500 to 700 turns per minute for the many cases where such a velocity is deemed expedient.

3. The stepping down of both velocity and pressure is possible at one and the same time and by the application of a small number of pressure steps.

4. In all these cases, all the practical demands for proper construction and driving qualities are to be fully met.

The first essential is the increase in the diameter of the wheel and its relative shape in order to control the peripheral velocity without the use of gearing. Laval did not work in this direction and apparently thought it impracticable; he was therefore compelled to confine himself to the use of gearing and limit his power to small machines not exceeding 300 horse power. Large, rapidly revolving wheels having diameters from 2 to 3 meters, turning 1500 to 3000 times per minute, and giving a peripheral velocity of 1300 to 1700 feet per second, can be constructed with safety. They demand, however, proper use and application of the material and excellent workmanship as well as great care in the control of the dynamic forces. Such wheels have till now not been built.

To give the wheel its proper shape demands an exact calculation in advance, especially of the effects of centrifugal force, which, however, like all other calculations of material forces can be done with absolute certainty. It is further essential that for a predetermined velocity none other than the calculated material forces and their effects be permitted and that these effects should be uncommonly favorable.

The wheels are constructed as solid steel disks. The buckets are not set in but cut in the rim of the disk. The disk is smooth on its outer surface and rim, to lessen the frictional resistance of the steam. Such disks may be exactly balanced without difficulty, by simple means.

The centrifugal forces tax the disk most severely at the center of the wheel. For this reason the wheel disk is not bored out for the shaft but is bolted to a flange at one end of the shaft. Where this is not practical the disk is made with a wide boss at the center, which tapers off to the rim, maintaining a cross section, which answers all demands and makes fullest use of the material (see Fig. 1). Large wheels afford a more advantageous use of the material, and with equal velocity the safety of the disk, at least up to a fixed limit, increases with the diameter. This is easily proven by calculation. Wheels of 6½ feet diameter for 3,000 revolutions per minute may be built of nickel steel with a five-fold margin of safety. But a five-fold margin is not required, two-fold, or at most two-and-a-half-fold is quite sufficient.

Unlike all other mechanical forces the centrifugal force is in effect completely without jar and is continuous, being repeated at each point millions of times. And yet we are satisfied with small margins of safety, especially in locomotives and marine engines.

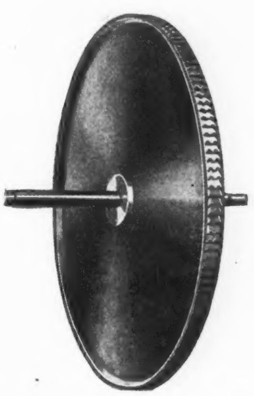


Fig. 2. Turbine Wheel Disk.

Fig. 3. Nozzle Ring.

The determinative point is the elastic limit or tensile strength of the material from which the wheel is made, at which permanent changes of form take place and should, of course, never be reached.

The first wheel built was made of nickel steel of 107,000 pounds tensile strength. This afforded a margin of safety four times greater than was theoretically required. Without danger then this might be reduced one-half.

When the extreme hardness of this material is considered the thought might well occur that there would be internal strains in the castings, more particularly in the heavier rim. To discover if such were possibly the case the first wheels were sawed across the rim, making many small slits in the periphery, and developments awaited. Should secondary tensions exist the telltale slits, by closing or widening, would disclose the conditions. Since, however, nothing of the sort followed there remained but to conclude that the castings were perfect inside and out. These slotted wheels were also driven at a velocity of 1000 feet per second without unfavorable results, which also proved that the original calculation, in spite of the weakening of the rim, provided for a sufficient margin of safety against the pull of the centrifugal force.

Different, too from the mounting of the Laval wheels is the construction employed in setting up the Riedler-Stumpf turbines.

De Laval's pliable shaft would not answer for large, heavy, rapidly-moving wheels. To obtain any appreciable bend in the thicker shaft necessary to carry the heavier wheel, the bearings would require to be very far apart. Quite the con-

* Abstract of paper read by Dr. A. Riedler, Berlin. Published by the Schiffbautechnische Gesellschaft, Berlin, and translated for MACHINERY by Chas. A. Brassler. The Riedler-Stumpf turbine is of the De Laval type, having expanding nozzles from which the steam issues in jets and impinges against the wheel blades. The buckets are similar in construction to those of the Pelton water wheel and the turbine is constructed either in one stage, like the De Laval, or in two or more stages, like the Curtis turbine.—EDITOR.

trary is the case here. The bearings are placed as close as possible to the wheel, so that any give in the shaft is next to zero.

However, the wheels are perfectly balanced upon the shaft, and the inexactitude of the center of gravity corrected to within 0.004 inch. By indefatigable exertion this state—the one in which they are delivered from the works—may be still further corrected to within 0.0004 inch.

The center of gravity of a wheel so carefully adjusted is so true that it will be impossible to exceed the critical velocity, and in fact will not be appreciated by anyone but the most experienced expert.

walls which prevent the escape of the steam in any other than the desired direction. The water of the Pelton is not led away, but escapes as best it may, while in the case before us the steam is directed as well at its exit as at its entrance. No packing is needed on the interior of the wheel, as in the De Laval, and there is some considerable play between the rim of the wheel and the mouths of the nozzles. An increase of this distance to 0.2 inch has not shown any lessening on the pressure upon the buckets nor in the work accomplished. In the 2,000-horsepower wheel at Moabit, near Berlin, the radial distance between the nozzle and the bucket is 0.12 inch; in a tangential direction, 0.39 inch. Here we have no axial thrust

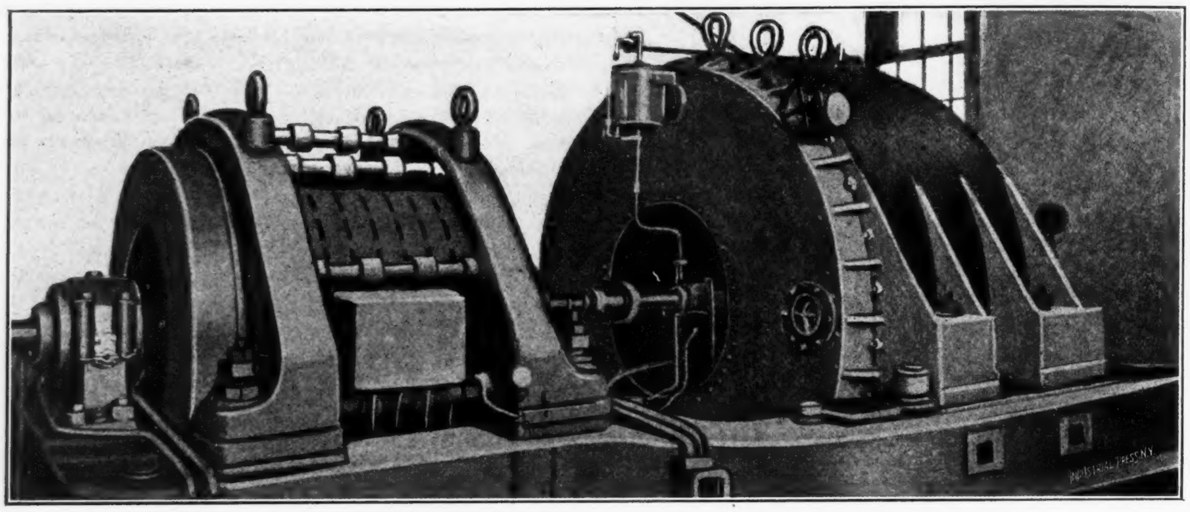


Fig. 4. Two-thousand H. P. Riedler-Stumpf Steam Turbine Direct-connected to Electric Generator.

Having exceeded the critical velocity the condition of dynamic equilibrium could only be found by a slight movement of the axis. For this purpose De Laval made his axis pliable, but in the balanced Stumpf turbine the slight motion of the shaft in its bearings is sufficient. The running of the shaft, even when turning 3,000 to 4,000 times a minute, is faultlessly quiet. The motion of the machine is neither sensible to the touch nor to the eye. Having reached such perfection in the wheel, it was an easy matter to simplify other accessories. As above stated the buckets are not set in, but cut in the solid rim, and these may be cut one, two, or more at a time on the milling machine. The resistance to ventilation is greatly improved or lessened by the overlapping, shingle-like construction of these buckets. If the power is not applied all around the inoperative parts may be uncovered by partitions, which lessen the resistance.

Having the buckets on the exterior of the rim affords a more advantageous adaptation of the nozzle angle; though the effective leverage of the wheel when in motion is slightly decreased thereby. Again, having the buckets on the top of the rim instead of on the side of the rim, as in the De Laval, permits the delivery of the full force of the cross section of the flowing power. In the De Laval nozzle the stream of steam strikes the wheel in an ellipse, whereas with square nozzles of the Riedler-Stumpf type, it strikes it in a solid square. In the former system the impact is uneven, being greater in the center of the ellipse than at its outer edges, whereas with the square stream impinging point blank upon the buckets cut in the outer rim of the wheel all parts of the buckets are attacked with equal force. The Riedler-Stumpf nozzles have a square cross section and lie close together and the steam flowing from them forms a completely closed ring of power. This arrangement makes it possible to surround the whole wheel with nozzles by which many losses may be avoided. The buckets, too, are like little pockets, and constructed either as single pockets in which the steam enters at one side, passes to the opposite side, and exits at an angle of 180 degrees; or they are double pockets with entrance at the middle and exit at the side. The Riedler-Stumpf buckets remind one of the Pelton wheels, though instead of following one behind the other, as in the Pelton, they are one above the other, in layers; nor are they set in, but instead are cut in the rim. Again the Pelton buckets are open on all sides. These are provided with

as a consequence of the sidewise impact, which must be taken up in the De Laval by miter wheels, and in the Parsons by the compensating pistons. The wheels are made of steel and an admixture of 10 per cent. of nickel has been found the best to preserve them against the corrosive influence of rust. The principles of the peculiar shape of the nozzle were acquired by numerous experiments, which showed that form had a marked effect upon the degree of efficiency. In the nozzle the first important step is taken in the advantageous employment of the energy of the steam. It is here that the

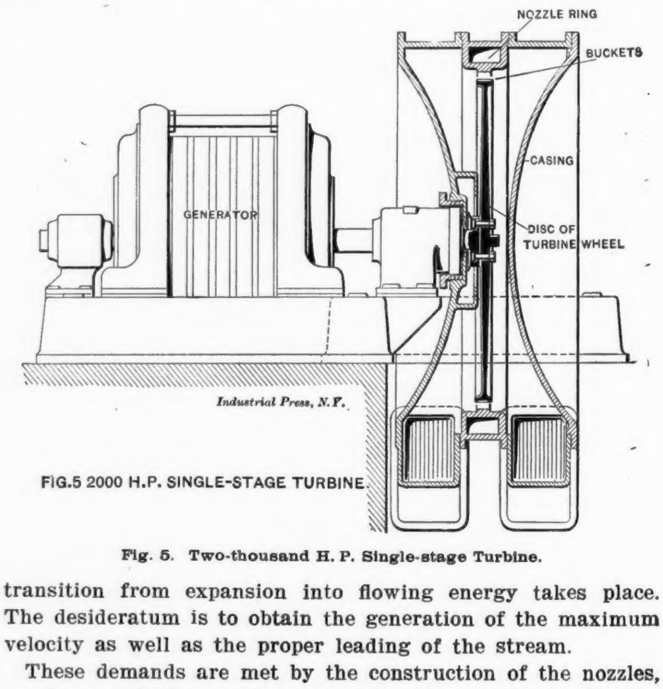


Fig. 5. Two-thousand H. P. Single-stage Turbine.

transition from expansion into flowing energy takes place. The desideratum is to obtain the generation of the maximum velocity as well as the proper leading of the stream.

These demands are met by the construction of the nozzles, as shown, which are of easy construction, while the De Laval nozzles, with their elliptical openings do not offer the possibility of grouping them properly together and assuring a reliable leading of the streams of steam one under the other. In Fig. 3 we show a complete ring of nozzles as furnished in the 2,000-horsepower turbine in the electric plant at Moabit, near Berlin. In wheels of less power the nozzles are placed

in a single group; in either case the regulation is such that the nozzles may be shut off one after the other from a central point.

The first 500-horsepower experimental turbine constructed is in the machinery department of the Technical High School. It consists of two wheels of 1.5 meters (5 feet) diameter. Where the steam is exhausted in the open air only one wheel is used; with a condenser and an intermediate chamber for changing the direction of the steam, both wheels come into requisition. The nozzle apparatus consists of two rings faced together, in one of which the nozzles are cut so that the single streams form a closed ring. Its first test was made with a hydraulic brake in the Technical High School. In the meantime the Allgemeine Elektrizitäts Gesellschaft constructed an alternating dynamo and they are now coupled together at work in the electric plant. Speeding at 3,000 turns per minute neither the turbine nor the dynamo showed the least vibration.

Using the nozzle apparatus which was arranged for condensation, but only one wheel, the consumption of steam was but 28.6 pounds per effective horse power.

The next wheel built was just four times as powerful and is shown in Fig. 4. It is a 2,000-horsepower turbine for the same electric plant. In building this machine, for the sake of simplicity, though to the disadvantage of the effective force, several losses were permitted. About 5 per cent. of the velocity at the nozzles and 15 per cent. in the shape of the buckets, and an effective loss of 15 per cent. in the intentionally exaggerated exit velocity with which the steam poured into the condenser. In spite of these defects, it was found to

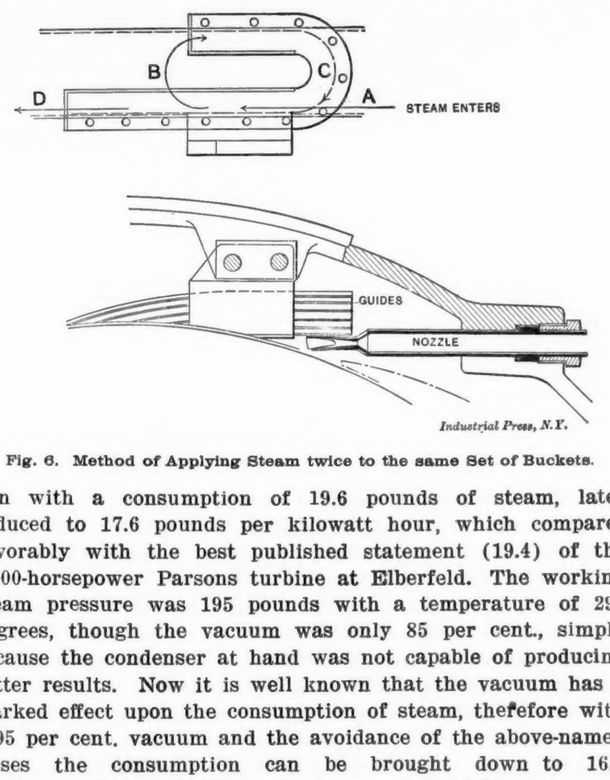


Fig. 6. Method of Applying Steam twice to the same Set of Buckets.

run with a consumption of 19.6 pounds of steam, later reduced to 17.6 pounds per kilowatt hour, which compares favorably with the best published statement (19.4) of the 1,500-horsepower Parsons turbine at Elberfeld. The working steam pressure was 195 pounds with a temperature of 294 degrees, though the vacuum was only 85 per cent., simply because the condenser at hand was not capable of producing better results. Now it is well known that the vacuum has a marked effect upon the consumption of steam, therefore with a 95 per cent. vacuum and the avoidance of the above-named losses the consumption can be brought down to 16.5 pounds per kilowatt hour. Again the exhaust losses can be diminished by increasing the diameter of the wheel from 2 meters to 3 meters (10 feet), which would bring the consumption further down to 14.3 pounds per kilowatt hour.

The packing of the shaft at its exit from the casing is done by an oil bearing. At the outer extremity of the oil box is forced a stream of oil which is sucked in by the partial vacuum within, and by means of a system of points the oil is all caught up and carried out again with such economy that during the running no loss in oil was apparent. The small weight of the wheel, 850 kilograms, (about 1,800 pounds), makes the question of keeping the bearings in perfect condition a very simple one. The construction of the one step Riedler-Stumpf turbine is the simplest of all turbines, and it meets at the same time all requirements for accessibility and economical consumption of steam.

The high-speed (3,000 revolutions per minute) is in many cases admissible, especially for alternating current dynamos, blowers, compressors, pumps, etc.; but it is by no means essential to the perfect working of the turbine. The same simplicity prevails when the diameter of the wheel is increased, reducing the number of revolutions to 1,500 per minute, but maintaining the same peripheral velocity. Since it is easily within practical mechanics to construct and run one step turbines of 5 meters (16½ feet) diameter, such wheels are applicable to the driving of direct current dynamos. Fig. 5

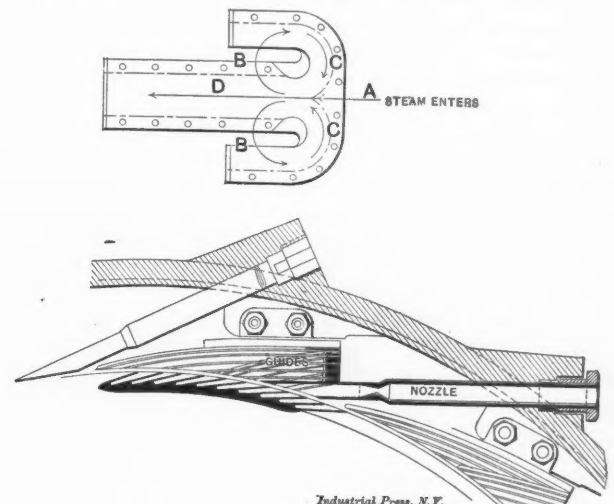


Fig. 7. Method of Applying Steam twice to the same Buckets when Buckets are of the Pelton Type.

is a sketch of a 2,000-horsepower Riedler-Stumpf turbine with a wheel having a speed of 3,000 revolutions. A wheel one meter larger in diameter would need to turn only half as fast to maintain the same peripheral velocity and deliver 5,000 kilowatts at the bus bars. In these huge dynamos the armature is so heavy that the shaft is strong enough to carry the wheel on the free end of the shaft close to the outboard bearing. The casing is therefore built around the pillow block, which thus serves a double purpose. All special bearings for the turbine are in this way eliminated, simplifying the construction still further. These wheels are built in one step, two, three, and four step forms. The stepping down of the velocity is the most effective way of reducing the number of revolutions, and this is done in two ways, one we have already shown by increasing the size of the wheel, the other by stepping down the pressure.

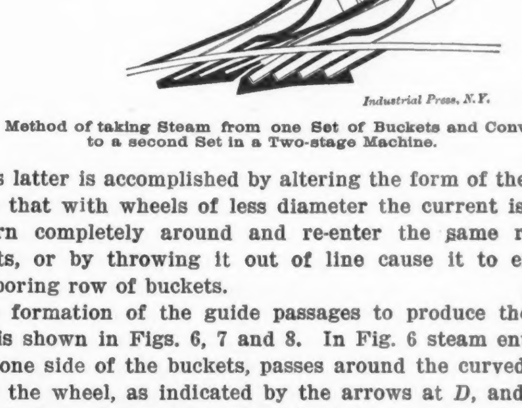


Fig. 8. Method of taking Steam from one Set of Buckets and Conveying it to a second Set in a Two-stage Machine.

This latter is accomplished by altering the form of the buckets so that with wheels of less diameter the current is made to turn completely around and re-enter the same row of buckets, or by throwing it out of line cause it to enter a neighboring row of buckets.

The formation of the guide passages to produce these results is shown in Figs. 6, 7 and 8. In Fig. 6 steam enters at *A*, at one side of the buckets, passes around the curved buckets of the wheel, as indicated by the arrows at *D*, and when it is discharged from the wheel buckets it enters the guide

passages, is deflected at *C*, and finally enters the wheel buckets again at the point *D*.

Figs. 6 and 7 show the method of conducting steam from the buckets of the first wheel to a second row of buckets of another wheel parallel and on the same axis with the first one. In Fig. 7 buckets similar to those of the Pelton water wheel are used, steam impinging at their center and passing both to the right and left. It enters at *A*, is deflected by the buckets at *BB*, whence it enters the guide passages and is deflected again at *CC*, and finally it impinges against the same row of buckets again in the direction of the arrow *D*.

In Fig. 8 steam enters in the direction *A* at one side of buckets *BB*, where it is deflected and then passes around guide *C*, and finally impinges against another row of buckets in the direction *D*. In Fig. 9 is a sectional drawing of a two-stage turbine, similar in its arrangement to the Curtis turbine made in this country. The upper wheel may be classed as a high-pressure wheel and the lower a low-pressure wheel. Steam enters as indicated, and is conducted by suitable pass-

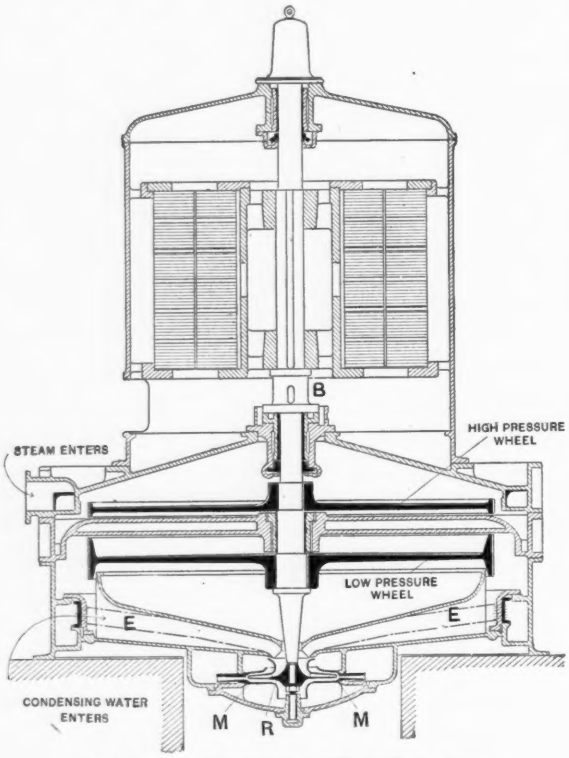


Fig. 9. Two-disk Machine with Vertical Axis.

ages from the first to the second wheel. It then enters the annular passage *EE*, where it comes in contact with condensing water which enters through openings in the periphery of this passage. The mingled steam and water then flow to the center where they enter between the two rotating disks at *R*. The condensed steam and condensing water are here thrown upward by centrifugal force and are discharged through openings at *MM*. This novel arrangement of the condenser insures thorough intermingling of the water and steam and produces a high vacuum. The shaft of this turbine and generator instead of being carried on a step bearing at the bottom is supported by a bearing, *B*, situated between the turbine and the generator.

* * *

ALTERNATING CURRENT MOTORS FOR RAILWAY WORK—AMERICAN DEVELOPMENTS.

WM. BAXTER, JR.

The alternating current motor for traction work is receiving a great deal of attention at the present time and those actively engaged in its development are very sanguine as to its future. The motor which appears to be the best suited to this class of work is what is known as the commutator type. Several experimenters in Europe have been working to develop this form of machine, and it has received considerable attention in this country, the most noteworthy results having been achieved by Mr. B. G. Lamme, of the Westinghouse Company.

The commutator type of alternating current motor is a machine that is practically the same as the ordinary continuous current motor; in fact the only difference, structurally, is in the field core which is made laminated. The proportions of the various parts are somewhat modified, but the action is the same, and one of these motors will run fully as well with continuous as with alternating current; and in fact will give a trifle more power with continuous current of the same voltage and same number of amperes.

Commutator motors of the alternating current type have been made for years, but, up to recently, their performance has not been satisfactory—the efficiency and output being low, and the sparking at the commutator excessive. The motors that have been developed within the last few years are far superior to those previously made, in part because they have been designed to be operated by currents of much lower frequency, but principally because greater skill has been exercised in designing them.

Alternating current commutator motors for a given capacity are larger than continuous current motors, and are of a somewhat lower efficiency. The difference in efficiency is not very great, but in weight the difference is between fifteen and twenty per cent. This latter difference is due in part to the fact that the field coils must be much better insulated to withstand the inductive action of the current, and in part to the fact that the power developed is not equal to the product of the volts and the amperes, but is equal to a percentage of this product, equal to the power factor of the current.

Although the alternating current motor is heavier and of a slightly lower efficiency than the continuous current machine, the difference is not great, and in many cases can be more than offset by the reduced cost of installation. For long distance traction work, with continuous currents, the present practice is to use alternating currents to distribute the energy from the central station, and to provide a number of substations where, through rotary transformers, continuous currents are obtained to feed the trolley lines. As the rotary transformers are moving machines attendants must be provided at the substations. With alternating current motors, the rotary machines at the sub-stations can be replaced by static transformers that require no attendance. These transformers cost much less than the rotary machines, so that the cost of installation and the operating expense are both reduced; hence for long roads the alternating current motors appear to have a promising future. Its advocates claim that it can be shown to be more economical than the continuous current motor, even for city work, owing to the fact that the speed of the motor can be reduced without introducing resistance in the circuit, hence without wasting energy, as is the case with the continuous current motor. While it is true that this waste of energy could be obviated, it is by no means certain that the saving thereby effected would be enough to offset the increased weight of the motors.

The advocates of the alternating motor, to show as great an advantage for it as possible, claim that it could be used with much higher voltage than is now employed on the trolley lines, some of them running as high as 4,000 volts, which they propose to carry right to the car, where it would be passed through a transformer to obtain a low voltage secondary current to operate the motors. While by such means the cost of line wires could be greatly reduced, the danger of seriously injuring the passengers if the insulation failed would be so great that it is doubtful if many conservative engineers could be found who would be willing to indorse the plan. From present indications, however, the alternating current motor can make a place for itself in the railway field without resorting to such wild engineering as the transmission of 3,000 or 4,000 volt currents through the trolley wire, even much less their transmission directly to the car.

Besides the work of Mr. Lamme, of the Westinghouse Company, the most noteworthy attempt to use the single-phase alternating current is to be found in the Arnold system, in which both compressed air and electricity are employed. The motor is operated at constant speed under constant load, the means for increasing or diminishing the power required to operate the car being supplied by the compressed air. The

electric motors thus have to be only large enough to propel the car and its machinery under average conditions, and when a given number of cars is in use the power house will operate under a uniform and constant load—quite an unusual condition in railroad work.

[The motor arrangement, as has already been explained in MACHINERY, is such that both the rotor and stator can revolve. One of these is geared to the car axle and both rotary elements are connected to an air engine which can act either as an air compressor or as a motor. By throttling one compressor it can be slowed down and as the rotor and stator must always run at the same speed relative to each other, the other compressor, together with its motor connection, will speed up accordingly, provided the demand for power is not above normal. If the demand is above normal, then one or both of the air engines acts as a motor, operated by the compressed air from the tanks. When the demand is below normal, air is compressed in the tanks by the air engines, which then act like compressors, and is thus in readiness for the next call for extra power. By thus manipulating the air engines, a greater or less degree of power is available for driving the car, as required, and the car can be run either faster or slower than the synchronous speed of the motor.

An important feature, due to the compressed air, is the fact that the car can be driven a short distance by compressed air alone, as in switching or through thickly populated districts, where the presence of a high tension current is objectionable. Mr. Arnold's work has been done in the vicinity of Chicago, and unfortunately his experimental car has recently been destroyed by fire; but another one is to be built.—Editor.]

* * *

THE SINGLE-PHASE MOTOR IN EUROPE.

DR. ALFRED GRADENWITZ.

The single-phase motor for electric traction is best developed in European practice in the motors of Dr. Finzi, of Milan, Italy, and of the Union Electric Company, of Berlin, Germany. The series single-phase motor designed by Dr. Finzi works at constant voltage, regulating its speed automatically, according to the load, the speed being inversely proportional to the latter for high values of the torque. It permits of voltage regulation without losses and of the speed being varied within very extensive limits. On the other hand it is not able to use high voltage directly and at present is bound to relatively low frequencies. Compared with continuous current motors it is found to require fewer watt hours per ton in starting, and the characteristic curves for the single-phase motor are very good indeed.

In November, 1903, a description of the Union Electric Company's motor was published in MACHINERY. Since then the results have come to hand of interesting experiments made by the Union Electric Company on the Spindlersfelde-Johannisthal electric line. This line has been in regular operation since the 15th of August, and has been inspected by a great number of German and foreign engineers. At the present time single motor cars, exclusively, are run; it is intended, however, to run trains made up of two motor-cars and trailers later on. The motor-car, including the whole of its equipment, weighs 52 tons, the electric equipment weighing 6 tons. It is fitted with two 125 horse power motors, mounted on the same rotary frame, one exciting system, and one controller at each end of the car. The car is so designed that any desired number may be coupled together and be operated by one guard. The current is collected by two short bows; automatic safety devices and fuses afford protection against excessively high currents. There is in addition a small transformer to supply current for the pneumatic pumps, as well as the controlling and lighting circuits. There are no shunt resistances.

The motors, constructed by the Union Elektricitäts Ges., according to Winter and Eichberg's data, are designed for a tension of 6,000 volts and for 25 cycles. They are permanently connected in series, and though their efficiency with full speed is, as a matter of course, somewhat less than the efficiency of direct-current motors, this advantage of the latter is offset by their great energy consumption in starting.

The trolley wire of the line conveys the electric energy at a tension of 6,000 volts, the running rails serving as a return circuit. The trolley wire shows some novel features, as instead of being supported by transverse wires the working wire is suspended from longitudinal wires in the form of nearly loose catenary curves. From these longitudinal wires, thin vertical wires are suspended at distances of about three meters, to support the working wire. Part of the track is fitted with one bearing wire, whereas the remainder has two such wires; experiment will show which is the better design. This arrangement of the working wire, where the latter has nearly no tension, will materially diminish the danger of breaking it, and as the suspension points are placed at distances not exceeding three meters, the consequences of a break are, at the same time, notably diminished, the end of a broken wire being beyond the reach of the railway *personnel.*

The Lamme and Dr. Finzi motors, being series motors which absorb immediately only tensions below 160 volts, the electric energy has to be reduced to this low tension. The motors designed by the Union Company can operate under any voltage, and are therefore connected directly with the primary circuit, with the exception of a small portion of the circuit, viz., about the sixth part of the energy, which is reduced to low tension. These advantages will result in small weights of the cars and an improvement in the efficiency, the first point being specially important in connection with narrow gage railways. The small gage railway motor of the Union Company is designed for 40 cycles, so that no difficulties will be met with in lighting the cars, as is the case with motors that operate with much lower frequencies. The greater advantage, however, is the fact that alternating current railways, according to the Union system, may be supplied direct from the same machines designed for supply of light and power, special plants and machines thus being unnecessary in the case of small gage railways for light traffic.

From these trial runs great consequences may be anticipated for the electric industry. In fact, in many cases where present systems are not able to afford sufficient saving to justify electrification the Union system is likely to be used advantageously on account of the absence of sub-stations, the lower cost of equipment of the line, and the high efficiency of the power transmission. The scheme will also be especially advantageous in connection with mountain railways, and long tunnel sections, metropolitan, as well as suburban.

* * *

LARGE WESTINGHOUSE-PARSONS TURBINES.

The Westinghouse-Parsons steam turbine was commercially introduced about four years ago in sizes of 600 horse power. Subsequent development has been so rapid that turbines of 5,500 kilowatts or 7,500 horse power, have been designed and are now under construction. A 5,000 kilowatt unit, of the same general type as these largest machines is illustrated herewith, and its distinguishing features are extreme compactness and low rotative speed. Machines of this type will form the initial equipment of the Pennsylvania Railroad Terminal property in New York City, operating the heavy Pullman trains through the tunnel approaches to Manhattan; and similar installations of turbines and generators are to be made in Philadelphia and London for street railway work.

The space occupied by the 7,500 horse power turbine is approximately 27 feet 8 inches by 13 feet 3 inches, and the height to the top of the hand railing is 12 feet. This is equivalent to .049 square foot (less than one-twentieth square foot) per electric horse power capacity, or 20.2 horse power per square foot of floor area required.

For the complete unit a rectangular area of 47 feet 4 inches in length and 13 feet 0 inches in width is required, which is equivalent to .084 square feet per E. H. P. capacity, or 12 E. H. P. per square foot of floor space. The 5,000 kilowatt units operate at 750 revolutions per minute, the 2,000 kilowatt unit 1,200 to 1,560 revolutions per minute, and the 1,000 kilowatt unit 1,500 to 1,800 revolutions per minute, depending upon the frequency desired.

In the new machines virtually the same general plan of construction and method of using the steam expansively have been retained that were employed in the earlier turbines, and

which are very familiar to all readers of technical papers. The single horizontal drum which carries the turbine blades must, however, be supported with unusual rigidity in so large a machine and a novel form of shaft construction has been adopted. A central steel quill carries the entire central rotating parts.

Hollow forged steel ends are forced into the two ends of this quill, under hydraulic pressure, and are in addition secured by arrowhead links. High pressure steam is conveyed to all parts of this quill structure in such a manner as to eliminate stresses and consequent distortion due to highly superheated steam.

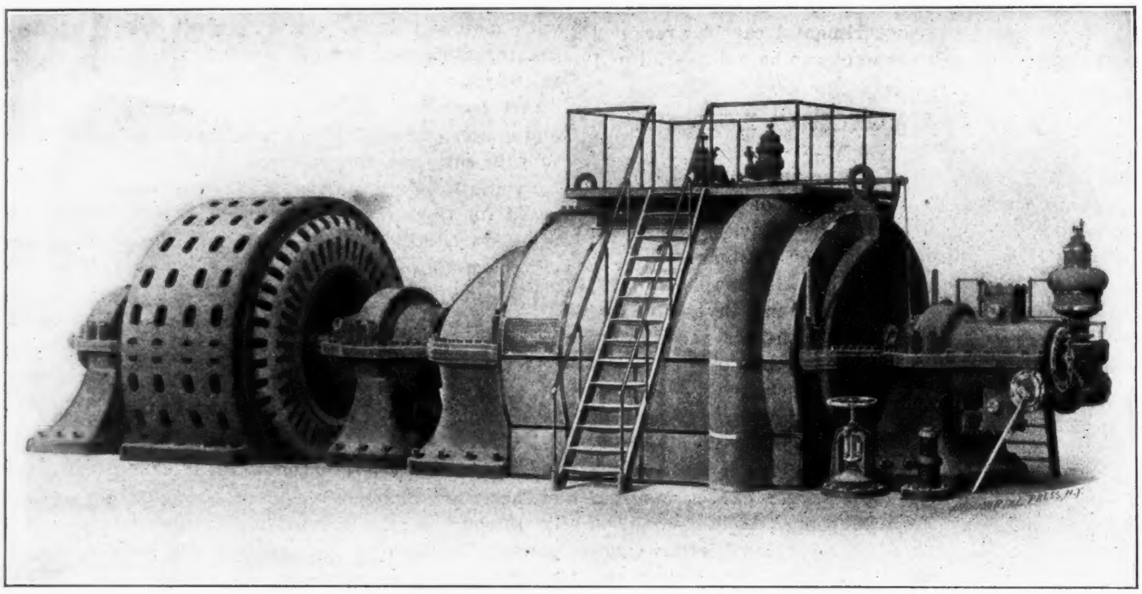
The journals in the larger machines are of the solid self-aligning type, similar to that employed in generators and cross-compound engines. The departure from the familiar oil-cushioned journal employed in the small machines is occasioned by the speed reduction secured. The journal shells are babbitt lined and are split horizontally, the two halves being united by bolts with shim adjustment. Oil from a central system is introduced at the center under slight pressure, thoroughly flushing all parts. The diameter of the shaft at the journal of a 5,000 kilowatt machine is 15 inches, strikingly small in comparison to the 34-inch shafts required for a cross-compound reciprocating engine of corresponding capacity.

An important feature of the steam distribution system is the provision of a by-pass valve. This valve admits high pressure steam to the second stage of the turbine on overloads in order to increase its capacity, up to 50 per cent. in excess of full rated load. By properly proportionating the by-pass steam to the overload on the turbine, maximum economy may at all times be secured together with reserve overload capacity. This results in a slight rise in the economy curve on heavy overloads, resembling in some respects the engine economy curve on loads exceeding that of maximum economy. The turbine, however, only suffers in economy at heavy overloads, while the engine economy decreases progressively from 75 to 80 per cent. of full load capacity.

The main admission valve consists of a double-beat poppet valve operated by a small piston, this in turn being controlled by a small pilot valve directly actuated by the governor mechanism. The valve admits steam to the turbine in puffs, the duration of which is proportioned by the governor to the load upon the turbine. This intermittent method obviates the throttling of steam.

* * *

A writer in *Sparks from the Anvil* refers to the alleged fact that steel will not harden in boiling water and says that the reason for this phenomenon is not apparent since it will harden at higher temperatures as he has proved. He has hardened a chisel in a bath of melted tin, the temperature of which is about 465 degrees F., so that it cannot be the mere heat of the boiling water that prevents steel hardening when dipped in it at the ordinary hardening heat.



Westinghouse-Parsons 5000 K.W. Generator for Pennsylvania Railroad Terminal, New York.

NOTES FROM MANCHESTER, ENGLAND.

JAMES VOSE.

Notwithstanding a fairly steady output, the year 1903 has not been characterized by general briskness in the engineering trade of the Manchester district, and the returns of the principal trades unions show an increasing percentage of unemployed amongst their members. Several concerns have, however, been extremely busy. Geo. Richards & Co., Ltd., have double shifts in several departments most of the time. The output during 1903 has been a record one. The pressure of orders is such that important extensions and rearrangements of the shops are under consideration. Boring and turning mills up to 10 feet in diameter have been in great demand, many of them fitted with individual motors—a practice found by Geo. Richards & Co. decidedly on the increase. By means of their patent feed box a large range of positive feeds is instantly obtainable, and their latest improvement is a patent balancing arrangement to the tool bars or slides which entirely dispenses with weights and chains, thus removing what is an objectionable feature in machines as generally built. A recently introduced machine is a duplex turret head boring and turning mill to deal with work up to 24 inches diameter, which has been received with considerable favor, a ready market having been found for the initial machines.

A specialty with this firm is Pearns' pipe facing machine, originally introduced by Mr. Frank Pearns, for facing all descriptions of pipes; but this title is now almost a misnomer, as the machine is so easily adapted to cylinder boring, turning, milling, special facing, etc., that the word "pipe" might well be omitted. A detailed description of this tool might be in order later on. Other lines which have been in good demand are side planers and horizontal boring machines, and the air compressor and sand-blast branches of the firm's business have been continuously engaged on orders throughout the year.

On the other side of Manchester, Bradbury & Co., Ltd., Oldham, are bringing out a turret lathe specially adapted for heavy work. I recently availed myself of an opportunity of seeing it at work, and having its advantages demonstrated, and was very favorably impressed with the solidity and excellent finish of the tool and the ease with which, notwithstanding its massive proportions, it may be manipulated. The hollow spindle has a 4 1-16-inch hole through it, the diameter of the front bearing is 8 inches, and the rear one 5½ inches. A range of 18 speeds in geometrical progression is obtained by friction double and treble back gear in the headstock, and a special countershaft, and by a few quickly-made changes about 60 feeds are available. The tool right through seems a capital blend of the good points of British and American practice. It weighs about 11,000 pounds.

Small turret lathes for the electrical and similar brass-finishing industries have been a strong line with the company

for some time, and several important detail improvements were brought to my notice, including a new automatic stock feed motion, dispensing with the objectionable features of the usual wire-feed arrangement.

Mr. S. N. Brayshaw, of Manchester, whose work in the manufacture of milling cutters and analogous fine tools has, during the last few years, attracted considerable attention, has recently made a decided step in advance in the direction of the precisional hardening of cutters, etc., made from carbon steels. As the result of experiments extending over a considerable period, he is now in a position to harden the most intricate cutters, tools, etc., with practically no risk—in fact, the hardening risk has, in his own practice, to all intents and purposes, disappeared. As a result of the fact being made known to the engineering trade he has been almost overwhelmed with hardening orders from outside concerns. In consequence of his researches, he believes he is in a position to prove that in many cases tools may be satisfactorily hardened or ruined within a temperature range of 6 degrees, and can demonstrate a distinct change of appearance in the fracture of a piece with a variation of 1 degree. In the process, which is protected, the articles are partly heated in a gas furnace and then transferred to a special furnace where they are immersed in a bath or melt of salts, the temperature of which can be regulated by means of Bunsen burners and a very delicate electrical pyrometer to within a fraction of 1 degree. After remaining in the melt a length of time varying with its character, the article being dealt with is plunged into water, and the operation is complete. A careful record is kept of every article hardened, and the correct temperature having been found, any number of pieces of the same shape and composition of steel may be hardened with absolute certainty. Mr. Brayshaw prefers hardening customers' own work, but is open to supply furnaces, pyrometers, etc., with the necessary instructions, where such is desired.

Following a prevalent tendency, Meldrum Bros., Ltd., have recently built and equipped a new works on modern lines at Timperley, 7 miles out of Manchester, and are already feeling the benefit of their new facilities for the handling and production of their specialties. Their old shop in Manchester was described in these columns some years ago.

The joint committee of the Manchester Municipal School of Technology and the Manchester Association of Engineers have presented their report on experiments with high-speed tool steels. The report is of an elaborate character. The chief deductions to be drawn from it are, that comparatively moderate speeds and heavy and coarse cuts will remove more metal in a given time than very high speeds and lighter and finer cuts; and that the power required for high-speed cutting does not increase in anything like the same ratio as the speed.

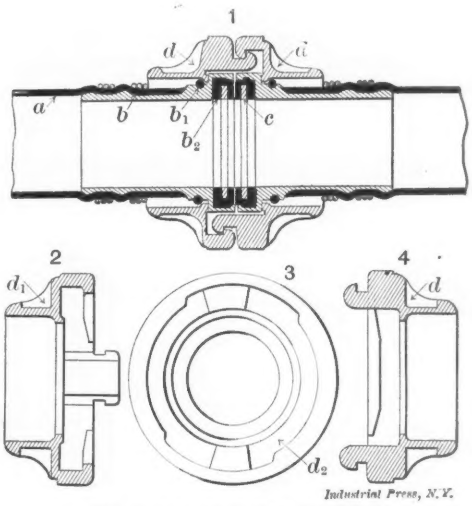
* * *

THE STORZ SYSTEM OF PIPE COUPLINGS.

The Storz coupling, like all others of its kind, consists of three principal parts: The lock, the packing and the cover, the latter being entirely independent of the first two. The coupling is formed in two halves, of which the lock and the fastener are exactly alike. The lock takes holds of a groove with a bayonet motion. Since each half, d and d_1, has two hooks, the coupling is held together at four points, two of which are quite sufficient to maintain a perfectly tight joint, so that the other two merely serve to strengthen the connection and act as a reserve. The locking mechanism turns about the binding ring which holds the packing in place, and yet the lock can be turned for coupling or uncoupling without revolving the packing with it, and furthermore, a worn out piece of packing can be removed and replaced without separating the joint. A strong ring protects the bayonet hooks from injury, both when they are opened and closed.

In coupling, the bayonet hooks first slide in the grooves and then enter a decreasing screw surface, so formed that the coupling cannot open of itself, while a slight backward movement of the coupling serves to tighten the packing. The dimensions of the grooves are such that coupling and uncoupling with the dust and dirt that may accumulate in them has no influence whatever. In addition to this there is so much play allowable between the different parts that even when made upon a large scale there is no trouble at all in securing perfect interchangeability.

The construction of the coupling is shown in the illustration; Fig. 1 being a longitudinal section of the whole, while Figs. 2, 3 and 4 are the details. The packing is self-tightening, both by internal as well as external pressure. The rubber-



Figs. 1 to 4. Storz Pipe Couplings.

lipped ring, b_2, is pressed more and more tightly into place the higher the water or air pressure in the pipes. These rings are so set in the ends of the pipe castings that they cannot be forced out by any pressure, no matter how high it may be, and further, even when the coupling is opened, the rings are so arranged that they are still protected by an extra outside ring.

* * *

In the May, 1903, issue mention was made of the magnesium-aluminum alloy known as magnalium, which has a specific gravity of 2 to 2.5, and other valuable characteristics. Carl Zeiss of Jena has developed two light aluminum alloys called zisium and ziskon which, although heavier than magnalium, have special characteristics that make them also of interest. Zisium has a specific gravity of 2.95 and is somewhat ductile. It makes excellent castings of close texture and rigid structure. The metal works well in the lathe and is handled the same as brass, being turned dry. Tests show that it has a tensile strength of about 11,000 pounds per square inch of section, and an elongation of 0.9 to 1.3 per cent. It takes a high polish and is silvery-white in color. Ziskon is stronger, having a tensile strength of about 25,000 pounds with an elongation of 0.7 per cent. It is heavier than zisium, its specific gravity being 3.35, and is less ductile. It also makes fine castings, works well, and takes a high polish. The unfortunate feature of most such alloys is that the best results can only be produced by an expert who makes his mixtures, etc., with all the accuracy required for a chemical analysis. How it is with these we are not informed, but if they are of the practical everyday nature of, say, brass or bronze mixtures, there should be a considerable field for their use outside that of the manufacture of philosophical and experimental apparatus.

* * *

The maximum boiler horse power in central power stations is only attained during a few hours of the day. During the greater part of the day the capacity required is much less than this maximum. On this account it has been found economical and practical to design the boilers and chimneys of ample capacity for this load and to force them above and up to the maximum by means of mechanical draft. This is applied with equal success to old and new plants. In the new power station of the Denver Tramway Power Co., Denver, Colo., mechanical draft is used as an auxiliary to the natural draft provided by a chimney 240 feet high. Artificial draft is furnished by three Sturtevant electrically-driven steel plate fans. The boiler capacity of the plant is approximately 6,000 horse power.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

The cost of concrete, of course, varies with the locality, but as a general statement it may be said to average one-half the cost of heavy masonry. For piers and abutments the cost of concrete is about $5 per cubic yard as against $12 per cubic for stone. In the vicinity of New York the cost of concrete is estimated at about $6 per cubic yard.

A novel testimonial has been presented to Mr. William E. Corey, president of the United States Steel Corporation, by his associates in the operating department of the Carnegie Steel Company. It is a silver model of a hydraulic forging press such as is used in the manufacture of armor plate, mounted on a base of classic design, the whole being made of silver having a total weight of 535 ounces.

The Girard College for orphan boys in Philadelphia was founded in 1831 by Stephen Girard, who left a bequest of $2,000,000 for that purpose. The chief building is a somewhat remarkable piece of architecture in a number of features. It is an early example of a building heated by the circulation of hot air from furnaces built in the cellar. Flues for ventilation were built in the interior walls which had their apertures in the apex of the arch in each room.

In relation to the protection of steel from corrosion Mr. Edward Atkinson says it appears that any paint on which reliance can be placed for the protection of steel or other metal from corrosion, must be one which dries by evaporation or sets like hydraulic lime. It must not be one which hardens by the oxidation of the oil or any other ingredient of the compound in which lead or other pigments are mixed. Steel has so great an affinity for oxygen that it is corroded by the oxidation of the oil itself.

In a hill-climbing contest at Eagle Rock, West Orange, N. J., November 26, a 30-horse power Mors racing automobile broke all records by making the distance of one mile uphill in 1 minute 36¾ seconds. Another machine, the Stevens-Duryea, made the same course in 1 minute 37 seconds. Eagle Rock is a famous hill that has been the scene of numerous bicycle and automobile hill-climbing contests. It is about 400 feet high and is approximately one mile in length with an average grade of 8 per cent. The steepest part of the grade, however, is estimated to be fully 15 per cent.

What may prove a valuable discovery, or rather, development of the "singing arc," is reported to have been made by some students of the Missouri University at Columbia, Mo. No details are given beyond that it has been found that if an ordinary telephone transmitter be connected in a certain manner with an electric arc lamp, the latter will reproduce whatever is spoken into the receiver, and with greatly amplified volume. The arc, it appears, acts as a giant receiver, reproducing laughter, cat-calls, college yells, etc., with a power never to be hoped for from the most hardened collegian brazen throat.

Mr. Edward Atkinson, the well-known fire insurance expert of Boston, does not approve, it is said, of the round bottom pails usually provided in mills and factories for subduing small fires. The round bottom, designed to prevent such pails being used for ordinary purposes, also, it appears, makes them very unhandy in case of fire. There really is little reason for not providing the readily obtainable and cheaper flat bottom galvanized pails for fire purpose in the well-ordered shop or factory. It argues for a very slack condition of affairs if such pails cannot be provided without their being used for illegitimate purposes.

Gear cutting is now done so rapidly by those concerns making a specialty of commercial work, especially the steel gears for street railway motors, that the difference in cost of the steel casting and the finished gear is a surprisingly small sum. One well-known gear-cutting concern making a specialty of this work cut the teeth of steel motor gears 20 inches diameter, 5 inches face, 3 diametral pitch at the rate of one tooth in one and one-half minutes. Automatic machines are employed for the purpose so that the labor cost of attendance is divided among a number of machines each having a capacity of from six to seven of the gears per day.

A railway company in Illinois has planned an innovation for the farmers along its line. It has rigged up a portable motor, and whenever any of the farmers want power to run a threshing machine, shredder, wood cutter or other machinery the motor will be set up in the farmyard or barn and connected with a portable wire connection to the lines of the railway. It is claimed that this will afford the farmers a cheap power for grinding and other uses. The railway people will also undertake a lighting plant for the farmhouse and barns.—*Electricity.*

The student engineer when told that the work required to lift a weight is identical whether done in a second or a century, accepts the truth with a lingering feeling of a difference existing somewhere, until he learns that difference to be one of power, or the rate of doing work. Then comes he to know *time* to be a very essence of the world; its root idea, speed—rapidity—dispatch. And so he finds it when coming to the larger activities of life. Time, and the saving of it, the keynote everywhere. Speed—rapidity—dispatch, demanded in mill and office, factory and store. Power thus comes to have a meaning new and wider than the narrow limits of technical definition. Power to do work well, and to do it quickly is the power that controls. Applied alike to men and to machines, it fixes the standard of worth.—*C. H. Morgan, in A. S. M. E. papers.*

One serious trouble with electric incandescent lighting is that, as the lamps grow old, their lighting power diminishes, but so gradually does the change come on that the user seldom notices it, although he may in a vague way be aware that the light is not as satisfactory as it was in the beginning. Some electric lighting companies make periodical renewals of all lamps and thus preserve the prestige of this method of securing excellent illumination; but this, unfortunately, is not the general practice. A lamp-making concern has recently perfected an incandescent lamp that automatically extinguishes itself when its lighting power has diminished about twenty per cent. With the use of these lamps it is expected that more general satisfaction will prevail, as it will be impossible to use lamps after they have outlived their period of maximum usefulness.

The time clock to register the comings and goings of employees is one of the modern shop institutions that has grown into general use within the past few years. "Ringing in" and "ringing out" is not a particularly pleasant feature of modern time-keeping to the average American machinist, to be sure, but is a great discourager of that form of time wasting—tardiness. But unless the foremen are promptly on hand, the apparent saving of time may be practically wasted by the men neglecting to commence work with the blowing of the whistle. It is a somewhat delicate task to insist that the foremen shall also register by the time clock, nevertheless it is done in the shop of the King Machine Tool Co., Cincinnati, Ohio, and the application of the rule does not stop with the foremen—the superintendent and even the president of the concern himself observe the rule, so that all are on an equality in this regard.

The matter of successfully and economically removing cylinder oil from the condensation of marine and other condensing engines so that it may be safely used for boiler feeding, seems to have been effected only indifferently in this country—so indifferently in fact that nearly all our stationary plants allow the condensation with practically all its valuable heat units to flow to waste. In English practice one of the most successful devices for this purpose is the Rankine cartridge filter which is made in simple, compound and triple effects. It consists essentially in the simple form of a perforated metal cylinder covered with a double layer of filter cloth. One end of the cartridge is left open so that water filtering through the sides may escape at the end. The cartridge is mounted in a suitable case, so that it may be readily removed and replaced by another with a clean cloth. The compound and triple effect filters work on an extension of the same principle. The water passes through two and three distinct layers of cloth arranged concentrically or otherwise.

The preservative effect of hydraulic cement on iron and steel work has been vaguely understood for many years by a few, and occasionally evidence to that effect is published. We have known of iron tanks being "whitewashed" inside with a thin layer of liquid cement to prevent rust, but for how long it is effective there is no data at hand to inform us. A case where a thick layer of cement was used to preserve thin riveted wrought iron pipe has come to public notice. Some forty-four years ago pipes were laid in New Brunswick, N. J., which were covered inside and outside with pure Rosendale cement about one inch thick. Samples of the pipes recently taken up show the metal to be in an excellent state of preservation. Another rust preventative that is little used, is any good white lead paint, filled with dry sand immediately after application. The writer knows of painted and sanded tin construction that has been used under trying conditions for some years without serious deterioration. A double paint and sand coat it appears would last indefinitely.

Round taper ropes have been used in this country—at the Comstock, where they were in use for about ten years, 1875 to 1884. The ropes, which were made by the J. A. Roebling Co., were two inches at the top and one and three-quarter inches at the bottom. The load at the end of the rope was about ten tons. In Reuleaux's "Constructeur" details are given of a taper rope used in the mines of Przibram, Austria, twenty years ago. The ropes were used to hoist from a vertical depth of 3,900 feet. They were built of crucible steel wire having a breaking strength of 120,000 pounds and were made with a very regular taper from the small end. One wire was cut every sixteen feet and a larger one was brazed on. Consecutively in the process larger ones were joined on until the rope was complete. Each rope was composed of seven strands around a hemp center, each strand being made up of six wires around a hemp core. The initial factor of safety due to static conditions alone, and without considering the effects of bending, was about seven. It is stated that the ropes lasted from three to four years, making 100,000 trips a year.—*Mining Reporter.*

A patent was recently granted to the Halske-Actien-Gesellschaft, Berlin, Germany, for a combination of steam turbine and dynamo, or rather dynamos, which, although somewhat novel, we believe has been proposed before. The idea is to reduce the velocity of the turbine revolving parts (which is of the De Laval type) by mounting the steam nozzles on a tubular shaft so that they may revolve in a direction opposite to that of the turbine wheel proper carrying the buckets. Steam reaches the nozzles through the tubular shaft, and both this shaft and that of the bucket wheel are connected to dynamos running in parallel so that while no mechanical connection exists between the two generators, they must keep in step in accordance with the well-known conditions governing the action of alternating generators running in parallel. Consequently the two revolving elements of the turbine must run at a fixed relative speed, the action and reaction being the moving force of the two generators respectively. The theory as to the turbine efficiency is that the velocity of the revolving parts may be reduced one-half without affecting it since the velocity of the steam issuing from the nozzles is unchanged relative to the buckets. This is true, but the velocity of discharge from the buckets *relative to the casing and the atmosphere* is one-half the peripheral speed of the bucket wheel, whereas, theoretically, it should be zero.

THE EFFECT OF VANADIUM ON STEEL.

L'Echo des Mines et de la Metallurgie.

When from 3 to 5 parts per 1,000 of vanadium are added to steel, it communicates remarkable properties. Properly speaking, vanadium does not bestow on iron or steel any new property, but it doubles the coefficients of resistance to fracture under all circumstances (shock, crushing, elongation, etc.), and at the same time imparts such extreme hardness as to render it possible to reduce almost by half the thickness of the armor for vessels. It is difficult to comprehend that the presence of from 1-3 to ½ per cent. of any element whatever in an iron alloy can have so intense and general an effect, though this effect is perhaps explained by the extreme avidity which under certain circumstances vanadium has for oxygen. This avidity might account for the fact that the presence of even the slightest quantities of vanadium in a bath of steel in fusion would lead to the immediate and absolute reduction of every trace of iron oxide still existing in the mass. Now to these traces of oxide, which are inevitable without vanadium, the rupture of the best prepared steels is attributed. Crystals, even microscopic, of oxides would act like the stroke of a diamond on the thickest glass.

A peculiar property of vanadium steels is that they acquire their maximum of hardness, not by tempering, but by annealing at from 1,300 to 1,500 degrees F. This has various consequences. For instance, a lathe having a cutter of vanadium steel may be set at work with greatly increased velocity. Soon the tool becomes heated, and even when it attains red heat, it still continues to take off shavings of iron or castings without exhibiting any dulling effect. It is almost unnecessary to remark that in such a case a cutter of ordinary steel would become completely softened and lose its cutting power. This property is of particular importance for projectiles. It is known that the shock which they experience on striking the target raises them to an elevated temperature. If, by means of vanadium, this temperature does not diminish the hardness of their points, and consequently all their sharpness is preserved, the penetrating force will remain intact. The applications of vanadium steel may be numerous. It is said that they may cause a revolution in armaments. The present price of vanadium in France is about $14 a pound.

SPINNING STEEL SHAPES.

Ryerson's Monthly, January, 1904

Metal spinning is one of the few lines of trade where machinery seems to have little chance of superseding the work now done by thousands of skilled mechanics, work which in complexity of design and excellence of workmanship is truly wonderful. The principle of spinning consists in forcing, by the continuous pressure of a tool of simple shape, a sheet of metal into a revolving pattern, or else raising it by the same method over this same pattern or chuck. In the first case the inner surface of the chuck must correspond to the outer contours of the article to be reproduced, while in the latter the chuck actually forms the pattern. One of the necessities for this work is a good spinning lathe. Almost any lathe with a few changes and attachments may be used, but it is always economical to have a machine properly designed for this particular line of work. The strains on a lathe to be used for spinning are great, calling for a heavily built and well-proportioned machine. The speed at which the lathe is run must depend on the work and the quality of the metal used. A speed of from 15,000 to 22,000 revolutions per minute is about the usual rate.

The chucks or patterns are usually made of hardwood, generally white beech. Metallic chucks cannot be used, as in this case the sheet metal would very quickly spin hard. The

chucks must be turned very smooth and be so arranged that they can be secured firmly to the mandrel. Where a small hole in the metal is permissible a steel rod about a quarter of an inch in diameter is used. This peg, as it is called, passes through the metal blank to be spun and also through the chuck, is arranged with a thread at one end and a knob at the other, and holds the metal in place until it can be tooled down to the shape of the chuck. The spinning or tooling down is done with tools of various shapes and designs. They may have faces which are flat, club-shaped or curved, but are always very smooth and the edges are kept dull. The shape of tool best fitted for each kind of work is learned only by experience, it being next to impossible to give definite directions for the many kinds of work which come up. The plate of steel is made to revolve by the mandrel, while the tool is pressed in slow strokes against it until the plate has gradually fitted itself to the pattern. After this has been done a flat tool is used to press out the metal. Care must always be taken that the metal does not wrinkle, and for this purpose, in the first part of the spinning, a flat surface is held under the plate and opposite the tool. After spinning the tension is relieved by hammering with wooden mallets and by annealing.

KRUPP'S IMPROVED SPRING STEEL.

Mechanical Engineer, November 7, 1903, p. 623.

A recent patent granted to Fried. Krupp, of Essen, relates to steel suitable for the construction of springs, and has for its object, by a special composition of the steel, to simultaneously increase its tensile strength, elasticity and toughness, in comparison with other well-known kinds of spring steel, so that a greater working capacity of the spring may be attained without increasing its weight. The first-class Martin and crucible steels hitherto employed for the construction of springs, such as those for railway vehicles, possess a strength when hardened of not much over 79 tons per square inch, with an elastic limit of about 63 tons per square inch.

The necessity has recently arisen for the construction of springs of steel which shall be capable of being subjected to considerably greater demands than the usual Martin and crucible steels hitherto employed for this purpose. To meet this necessity the spring steel, according to Herr Krupp's invention, is produced, containing 0.4 to 1 per cent. of carbon, and a comparatively large amount of silicon, say between 1 and 4 per cent., added to it. The raw material may be quite ordinary Martin steel, to which the required silicon is best added in the form of the cheap ferrosilicon, prior to casting. Experiments have proved that steel of this composition, when hardened, possesses an increased strength of about 14 tons at the elasticity and breaking limits, and may consequently be subjected to greater demands than the usual spring steels. The steel also shows where fractured a fibrous structure resembling wrought iron, a sign of the great toughness of the steel. These advantages are obtained, as will be seen from the preceding description, with quite a trifling increase in the cost of the ordinary steel, so that in the silicon steel a material is obtained which is well suited for the construction of springs.

COMPOUND METALS.

Engineering (London), December 25, 1903.

The successful welding of different metals, whose welding points lie more or less apart, is a problem which has long baffled the efforts of metallurgists; for, except in the case of precious metals, all attempts in that direction have, until recently, proved futile. This has been particularly the case when it has been tried to give iron or steel the appearance and qualities of superior metals, such as copper, bronze, or aluminium. Metals whose welding points lie fairly close together have been made to unite by heat and pressure, as, for instance, iron and copper; but the result was of no practical value, because of the brittle alloy which was formed at the junction of the two metals, and which caused them to separate during subsequent rolling processes. This serious defect appears now to have been overcome by the invention of Mr. Heinrich Wachwitz, a metallurgical engineer of Nuremberg, who has succeeded in joining the most dissimilar metals by means of the application of aluminium between them, and without in any way impairing their natural ductility. Among the most important combinations produced in a commercial sense are, perhaps, the following: Copper-plated steel, aluminium bronze-plated steel, aluminium-plated steel, steel-plated aluminium, copper-plated aluminium, and silver-plated aluminium. Other useful combinations can, however, be produced, including triple combinations for special purposes. Copper can also be united to zinc, and lead to iron. The following are a few of the uses to which sheets made from compound metals have been, or can be, put, on account of their moderate price as compared with sheets made entirely from the more expensive metal used in any combination. Copper or bronze-plated steel for light yet indestructible roofing, in either flat or corrugated sheets, tanks, cylinder tubes, cooking utensils, etc. Aluminium-plated steel for the safe and wholesome canning of food for any length of time. Copper-plated aluminium for superior cooking utensils, and many special purposes where it is important to have a safe soldering surface, as well as the extra lightness over pure copper. Steel-plated aluminium for ship, yacht, and boat building, where rigidity is required combined with lightness. Silver-plated aluminium for table utensils, lamps, etc., the rolled-silver plating being much harder than electro-silver plating. The manufacturers contemplate making both copper-plated and bronze-plated iron wire, the uses for which will, no doubt, be numerous. The invention has already been worked successfully on a large scale for about two years by a German company, while two companies in France are also carrying on the manufacture of these compound metals. In England large works have been erected at Greenock for the purpose of manufacturing sheets rolled from these compound metals.

MACHINE SHOP FLOORS.

From Paper by A. Pringle before Canadian Society of Engineers.

In the matter of flooring it has been found that for ground covering something more rigid and durable than 2 or 3 inch plank laid upon sills, as formerly used, is necessary. Brick and many forms of concrete have been used with varying results, but unless laid with particular care they are very likely to settle, crack and wear into holes, becoming finally very uneven; in addition being objectionable from the operator's point of view in that they were hard and cold to work upon.

Another form of floor quite generally used at present is concrete foundation with nailing strips bedded therein. In some instances the tops of these strips were flush with the concrete, while in other cases the nailing strips in question projected 1½ inch to 2 inches above the concrete, thus forming, when the plank was laid, an air space between the concrete and the plank.

Still another form which the writer has used quite extensively and which he believes compares favorably in first cost, durability, rigidity and general service with any of the forms above mentioned, consists of a 3-inch cinder ground, well tamped to receive a 3-inch tar and cinder foundation, rolled level, over which is then laid hot a vulcanite composition 1 inch in thickness. Into this are bedded 3-inch sound hemlock plank, dressed one side and two edges, the rough side being well tamped into the hot vulcanite so as to give an even and true bearing. Toe nailing assists in laying plank true, but if the composition is properly made the adhesion of the plank to the vulcanite, after a few hours, is such that it is impossible to separate them without damaging the plank. The planking is in turn covered with two ply of tarred felt, cemented at the joints, over which is laid, preferably at right angles or diagonally to the planking, a 1-inch matched hardwood flooring, of narrow widths securely blind nailed.

A floor of this description is so rigid that all but the heaviest of machine tools may be erected upon and secured to it without other foundation. The composition prevents moisture reaching the wood, thus preserving it to a great extent from decay. The top flooring will, of course, wear out, but it can easily be renewed at comparatively small cost, as there remains a good foundation of plank to renew upon.

To the writer's knowledge one such floor has been in service for the past six years in a machine shop—all but four or five of the heaviest machines having no other foundation than the floor above mentioned—and all machines are to-day perfectly rigid and true, and the top flooring is not appreciably worn excepting at some few points where the traffic is heaviest.

For upper floors where brick, terra cotta or concrete steel construction is not used, the 4-inch plank flooring with 1-inch hardwood top covering is probably more generally used than any other. The 2-inch by 4-inch flooring laid on edge, instead of 4-inch plank, also finds some favor. This form of flooring is nailed through the side to the adjoining plank and to the running beams. The joints do not necessarily require to be broken on the beams and, therefore, there is probably less waste in laying a floor of this description than would be in the usual plank floor. In case of an extra heavy floor load or where an extra long span is required, 2 inches by 5 inches and even 2 inches by 6 inches may be used in the same manner. The material in question is usually dressed on four sides, one edge frequently being beaded or chamfered so as to give a neat ceiling effect to the floor below.

The writer has found it good practice to lay two ply of tarred felt, cemented at joints, between the lower and top flooring, for not only does this make it dust and oil proof, but frequently in case of a fire it prevents the water dripping down at many points on the machines below.

A floor of this description has been known to be flooded to a depth of 2 inches with water from the sprinklers, and the only leakage to the floors below was at the walls and columns.

KEEPING AN ENGINEER'S NOTEBOOK.

Mechanical World, December 4, 1904.

The compilation of a notebook is one of the engineer's most interesting and instructive occupations. If the compilation is made in an intelligent and systematic manner there is something to look back upon with genuine satisfaction. A private notebook should be characteristic of the writer, and not merely a collection of information readily accessible from a hundred sources. It should contain exclusive information, or at least information arranged in an exclusive manner, otherwise an engineer might just as well purchase one of the many books and save himself much useless labor. The principal points are the selection of the matter and noting it in a proper manner. With regard to selection, the young engineer should consider carefully the particular branch of engineering in which he is engaged, and his notebook should, for the most part, contain information relating to that branch, and should be written for himself only. He should endeavor to make it his ideal book on engineering, and although he may never realize the ideal he sets before himself, the endeavor cannot fail to be beneficial. As to the matter of noting information, there are two distinct methods of recording data and solving problems—the algebraic and the diagrammatic. Each method requires practice to handle rapidly and intelligently, and it is suggested that at the beginning the compiler should choose the one for which he appears to have most aptitude or inclination, and adhere to it as closely as possible. His book will then have a uniformity of treatment which will prove advantageous. Perhaps the diagrammatic system is the better, but this point need not here be discussed. Another important matter in the compilation of a notebook is to quote the source of the information and the date of entry, because if there is reason to doubt the reliability of the information at a later date, the source can be referred to and more carefully examined. Closely allied to the notebook, but distinct from it, is the scrapbook, into which cuttings from the technical journals and advertisements should be pasted. By arranging these in a systematic manner and keeping each class of machinery separate, an extremely interesting volume may be compiled, which will be, in fact, a practical illustrated book on the particular subject to which it refers. The compilation is a very fascinating occupation, as all those who have practiced it will admit; while of its utility there can be no question.

PYROMETERS: WITH SPECIAL REFERENCE TO THE MORSE HEAT GAGE.

Journal of the Franklin Institute, January, 1904.

The committee appointed by the Franklin Institute to investigate the merits of the heat gage invented by Everett F. Morse, Trumansburg, N. Y., gave in their report an interesting resume of the principles employed by others in the design of pyrometers.

Pyrometry is the term applied to measurement of high temperatures such as cannot be determined by the ordinary thermometer. There have been many methods proposed for the measurement of such elevated temperatures, and a number of quite satisfactory instruments designed. The importance of pyrometric determinations is daily increasing, and the field of usefulness of a good heat gage is an extensive one indeed.

Pyrometers have been made which depend on the method of mixtures, otherwise known as calorimeters, the principle of which is too well known to need description. Some have depended on the expansion of metallic strips or rods, and Messrs. Valy and Schorley employed a fluid alloy of sodium and potassium with mercury in a hard-glass tube by which means a temperature up 1,100 degrees F. could be read, as on an ordinary thermometer.

Carl Barus has given a classification of the principles on which pyrometers have been constructed. This appeared in the "Bulletin of the United States Geological Survey No. 54," 1889:

1. Dilatation of solids—
   (*a*) A single solid.
   (*b*) Two solids acting differentially.
2. Dilatation of liquids—
3. Dilatation of gases—
   (*a*) Expansion measured in volume, manometrically.
   (*b*) Expansion measured in pressures, manometrically.
   (*c*) Expansion measured in volume by displacement.
4. Vapor tension.
5. Dissociation.
6. Fusion.
7. Ebullition.
8. Specific heat.
9. Heat conduction.
10. Heat radiation.
11. Viscosity—
    (*a*) Of solids.
    (*b*) Of liquids.
    (*c*) Of gases.
12. Spectrophotometry and color. Rotary polarization.
13. Acoustics (wave length).
14. Thermo-electrics.
15. Electrical resistance.
16. Magnetic moment.
17. Miscellaneous.

The above classification shows that almost every form of thermal phenomenon has been utilized for pyrometers. Probably the most important in practical application, because of its simplicity, is the method of fusion, viz., by means of various metals which, when brought into a heated atmosphere, or in the vicinity of a heated body, will melt, the melting point being known; thus a temperature which will melt one alloy and not another can be said to lie between the two. This, of course, gives but approximate results inside of a wide range, and hence is limited in its usefulness.

The most important application of this method has been in the determination of temperature of hot blasts in connection with blast-furnace practice.

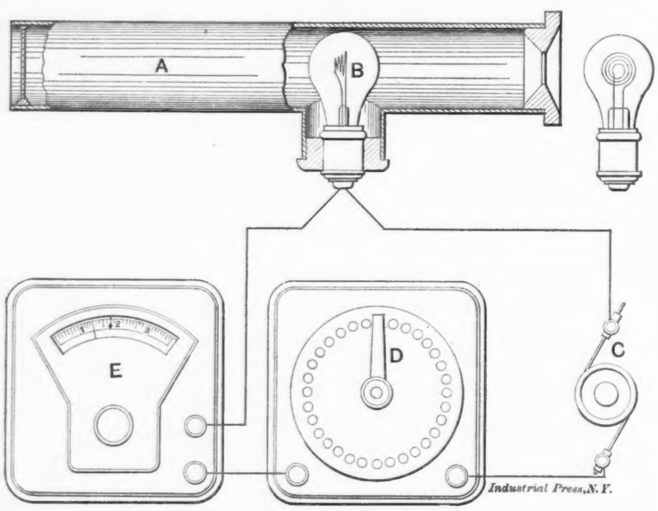
Quite a satisfactory pyrometer is built on the principle that if a current of water of known temperature be allowed to run through a coiled tube, the temperature of the out-flowing water will be proportionate to the temperature through which it has passed.

An important advance was made with pyrometric construction when Sir Wm. Siemens discovered that an instrument could be made to gage temperatures quite accurately, by comparing the resistance of platinum wire at ordinary temperatures with the same at an elevated degree. The method used is to pass a current through a platinum wire wound about a porcelain tube, balancing the resistance by means of another coil, so that equal currents will pass through both. The platinum wire when placed in the heated medium is increased in resistance—the smaller current traversing it. This current, compared with that passing through the standard coil, is reduced to temperatures recorded on a table. Other instruments have been produced which depend upon the electrical resistance of bodies at elevated temperatures, notably the one of Professor LeChatelier, which con-

sists of a thermo-couple composed of platinum and an alloy of platinum with 10 per cent. rhodium. Such a couple, under the effects of heat, is capable of generating a current which can be measured on a sensitive galvanometer. The galvanometer in practice is standardized for direct reading of temperature. This pyrometer is very extensively used at the present time for some purposes, but it is entirely too delicate a contrivance for every-day use in the foundry.

Other pyrometers have been produced, of which the Morse heat gage is a type, known as "optical pyrometers." In this, the eye of the workman, supplemented by an instrument which enables him to record the intensity of the radiations, becomes a pyrometer, so that the old method of judging temperatures by the appearance of the same is rendered comparatively accurate, and familiar indications of bright redness, etc., are subjected to direct measurements.

The optical pyrometer of LeChatelier is a photometric instrument. In this apparatus the rays emitted from a standard are compared with the rays emitted from a heated body whose temperature is to be determined. A red glass is interposed in the eye-piece and only red rays enter the eye. The photometer depends upon the adjustment to the same brightness of two images, one of the standard and the other of the compared body. The adjustment is made by means of two diaphragms having V-shaped notches opposite one



The Morse Heat Gage and Apparatus.

another. They are operated by means of a milled head, and the light admitted depends upon their respective distance from one another. The measurement of this distance compared with the distance apart when observing the standard light is reduced to temperature.

The methods of optical pyrometry employed previous to the invention of Mr. Morse are unreliable, chiefly because the optical standards for comparison have been placed to one side of the compared, and consequently such comparisons are greatly dependent upon the personal equation of the observer.

The Morse method of gaging the temperature of a material which becomes incandescent when heated, consists in comparing said material, heated to luminous state, with an optical standard so that at least a portion of one is in the path of the rays passing from the other to the eye observing the standard and material, and noting when the one immerges in the other to such a degree as to indicate the correct temperature within the necessary limits.

The apparatus consists first of a standard which is preferably a simple incandescent lamp (*B*), the temperature or color of which can be regulated by resistance (*D*) and the amount of current recorded on a milampere meter (*E*). The tube (*A*) containing the standard lamp may or may not be open at both ends, as desired. The tube is held so that the rays passing through the object of comparison will be superposed by the rays of the glowing lamp, the color intensity of which is regulated by the resistance. When the lamp is of the same intensity as the object, the former will be apparently obliterated from the view. At this point an observation of the ammeter and a comparison with the table (the result of calibration with a LeChatelier pyrometer) gives the ampere reading direct in degrees of temperature.

* * *

THE CONSTRUCTION OF WET AND DRY GAS METERS.

Journal of the Association of Engineering Societies, October, 1903.

One of the first gas meters invented was made of bladders, which were so arranged that one bladder would be filled with gas from the holder, and in expanding would force the gas out from another one already filled, and a valve system would shift the responsibility from one to the other, and thereby

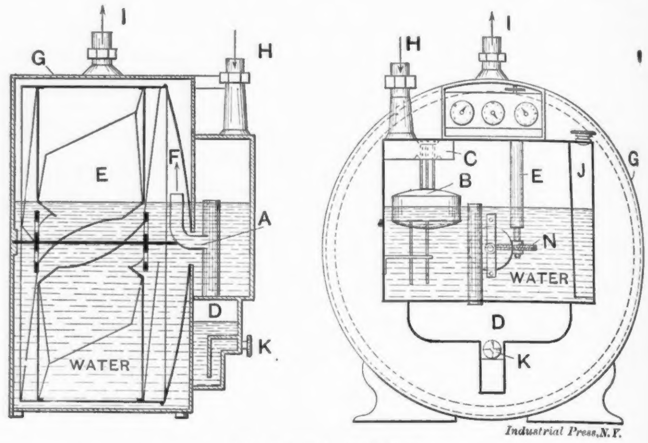


Fig. 1. Wet Gas Meter.

furnish a steady supply. This shifting of the valves by suitable clockwork registered the number of times each bladder had filled and emptied. In this way the amount of gas passed could be obtained. These bladders, owing to the properties of gas, soon became dried and cracked, and were finally abandoned for improved devices. The wet and dry meters were the final results of experiments on these lines.

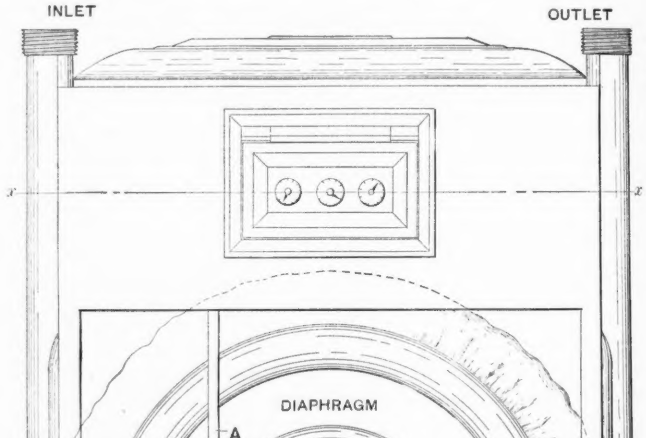


Fig. 2. Dry Meter, showing Diaphragms and Leathers.

The wet meter consists of a miniature overshot water wheel, *E*, Fig. 1, partially submerged in water and revolving on a shaft. This wheel or drum is divided by partitions into buckets or chambers in such a way as to admit the gas into one of the partitions above the water. The pressure of the

gas acting against the partition on one side and the water on the other causes it to revolve, and just before this section begins to shut off from the supply another section comes in and begins to take gas. Immediately after this, the first section shuts off the intake, and, being already filled with gas, begins to discharge the gas into the case which surrounds the drum. Given the exact cubical contents of these various chambers, the quantity of gas passed with one revolution of the drum can be ascertained; and properly constructed gear wheels, operated by a worm and wormwheel *N* on the main shaft, register the amount of gas that passes.

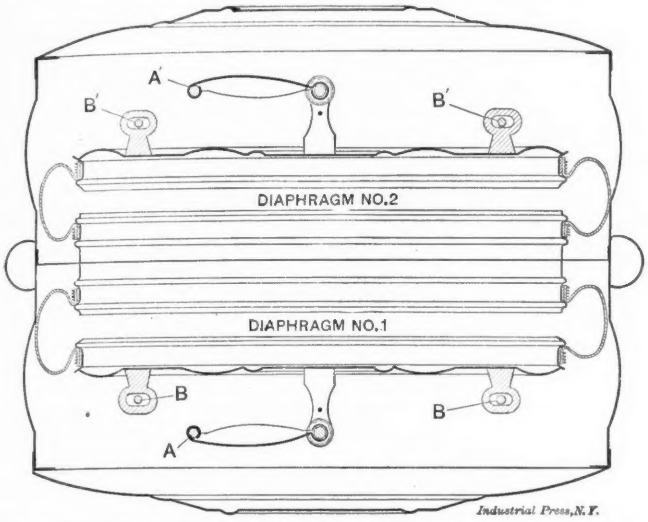


Fig. 3. Horizontal Section through Center of Diaphragms on Plane y-y, Fig. 2.

The dry meter operates through two slide valves, and the working parts of the meter are two or more diaphragms attached to the valves by means of rocking shafts *A A'*, Figs. 2, 3, 4 and 5, and link motion. The diaphragms are given freedom of movement by means of leathers attached to the diaphragms and to the partition between them, and the whole is inclosed in a case. As gas is admitted on both sides of the diaphragms, it is evident that movement of either diaphragm causes a flow of gas to the outlet of the meter. When one diaphragm is on the dead center, the other one is in full action, thereby producing a steady flow of gas. The links

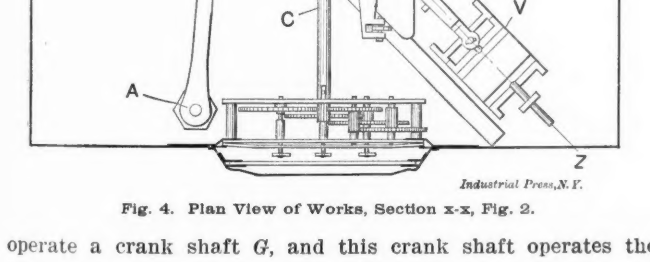


Fig. 4. Plan View of Works, Section x-x, Fig. 2.

operate a crank shaft *G*, and this crank shaft operates the valves *V V'* and the registering gear *C* through the worm *E*. The area of the moving diaphragm, multiplied by its lineal travel, will give the cubical displacement, and the consequent flow of gas can be known for a given number of movements of the diaphragms. The diaphragm leathers are soaked in oil, and so long as they remain sound the registration of the meter will continue correct. The chief difficulty, however, is that these leathers in time become hard, and the constant movement of the diaphragm cracks them and a portion of the gas begins to pass through without registering.

Fully 90 per cent. of the dry meters that are wrong are found to be slow. One can readily see from the construction of the meter that in order to make the meter run fast the travel of the diaphragm must be reduced, but the limitations of the crank shaft require a certain amount of motion on the part of the diaphragm to pass the dead center, and if this is not met, the meter will refuse to operate. The adjustment is made by the nut and screw on the crank at *D*.

* * *

THE VOGT GAS ENGINE.

Engineering (London), January 8, 1904, p. 37.

The author describes a new type of gas engine which in a model of 1¾ horse power promises most remarkable efficiency, this small engine having developed one indicated horse power with a consumption of 16 to 18 feet of town illuminating gas. In addition, it has mechanical features of great apparent value, as will be seen further on. A large engine of 1,000 horse power is to be built to prove the correctness of the design for large sizes—it has been amply proved in the small size in the opinion of the experimenters.

The Vogt engine is of the two-cycle double-acting type, giving in one cylinder two impulses per revolution. It has no water jacket, requires no lubrication and the working parts are at a normal temperature lower than the corresponding parts of a steam engine. This is simply effected by filling the cylinder with water and exploding the charges in vertical chambers above the water. Sections of the engines are shown on the following page, in Figs. 1 and 2.

The cylinder *C* carries vertical combustion chambers $B_1 B_2$, at its ends. The cylinder is completely, and the combustion chambers partly, filled with water, the height of the water in

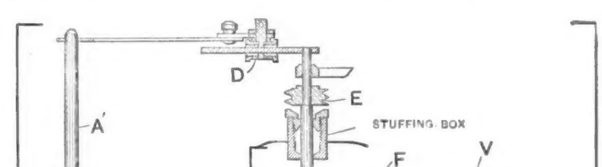
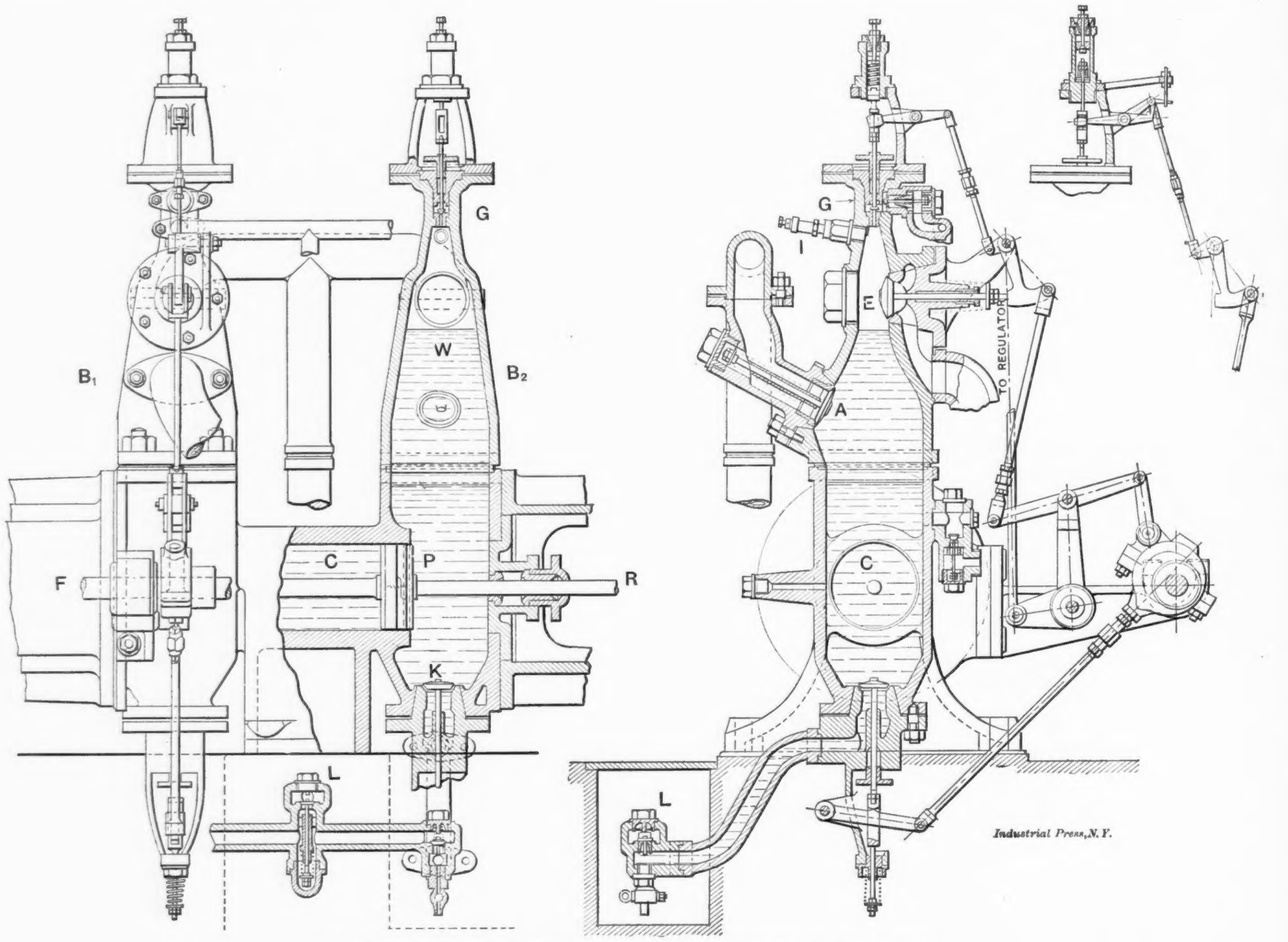


Fig. 5. Section through Flag and Crankshaft, Section Z-Z, Fig. 4.

the chambers depending on the position of the piston as it reciprocates. The gas, air, and exhaust valves are situated at *G*, *A* and *E*, and are all operated in a positive manner by means of eccentrics, rods, and trip-gear, as shown. Both the gas and the air are pumped to the cylinder under pressure, the gas pump being driven off the crankshaft by a crank-pin set in advance of the main crank, and the air-pump being directly attached to the extended piston-rod *R* of the motor cylinder. Intermediate receivers may be used for both gas and air supplies. An ordinary water service under about 10 pounds pressure is utilized to inject a little fresh water at each stroke, as required for cooling purposes, and below each vertical chamber are water valves *K*, communicating to spring-loaded valves *L*, which are so operated and adjusted as to retain more water in the chamber when the quantity of the explosive mixture is diminished, and so regulate the clearance as to give a constant compression pressure for all charges.

Starting with the piston in the position shown in Fig. 1, and with a charge of gas and air compressed in the chamber B_2—*i. e.*, in the space at the top above the water surface *W*—the action of the engine is as follows: Ignition is effected by the electrical igniter *I*, Fig. 2, explosion takes place and pressure upon the water surface at *W* drives down the water column, and forces the piston to move toward B_1, the work being transmitted through a crosshead and connecting-rod to the crankshaft in the usual way. Toward the end of the stroke the exhaust valve is opened and the pressure drops to atmosphere. The water level is then below the air-inlet valve, and this valve now opens, admitting air under slight pressure and in excess of the total combustion chamber volume, so that all the burned products are swept out and the cylinder left full of fresh air. If the engine happens to be

on full load, the exhaust valve closes soon after the in-stroke has commenced; at the same time gas is supplied under sufficient pressure to force it into the cylinder, and then both gas and air are compressed together. The amount of water expelled through the valve K during compression is in this case a maximum, and the final clearance is that necessary to give the desired compression pressure, which pressure is constant (being equal to that at which the spring-loaded valve lifts), and independent of the quantity of mixture or its temperature. On the other hand, if the engine is on light load, the exhaust valve closes later and the gas valve opens later, the first portion of the in-stroke serving only to expel some of the air previously drawn in. At a given point, determined by the governor, compression begins, and even with a light charge the same compression pressure is reached, but more water is retained in the chamber, so as to reduce the clearance to the proper capacity.



Figs. 1 and 2. Longitudinal and Cross-section of Vogt Gas Engine Cylinder.

From the operations described above it is obvious that a movement of the governor as the load decreases has the following results:

(a) Closing of exhaust delayed.

(b) Inlet of gas delayed and gas valve throttled.

(c) Amount of water escaping at valve K reduced.

Some of the advantages claimed for this engine are the following:

1. Same number of impulses per revolution as the steam engine.

2. Piston and stuffing-boxes under water, reducing wear and friction.

3. Air and exhaust valves always well cooled since they are under water once each stroke.

4. No unequal expansion between the piston and cylinder.

5. No water jacket required. Simple castings as thick as desired may be used.

6. Valve gear and eccentrics similar to those used on steam engines. All valves positive acting.

7. Quality of mixture and high compression remain constant.

8. With badly cleaned furnace or producer gas the dirt or dust has no injurious effect.

9. High efficiency.

* * *

VENTILATION OF THEATERS BY FORCED CIRCULATION OF AIR.

The ventilation and heating of a theater presents a problem not easily mastered by the ordinary heating engineer. In a crowded auditorium of this kind ventilation is the all important question. It may be a simple matter to heat the building to a required temperature before the curtain rises, but to maintain a constant temperature and a pure atmosphere while the play progresses is not so easily accomplished. The heat given off from the bodies of the closely seated audience is sufficient to raise the temperature in the house from 5 degrees to 10 degrees during the performance. Fresh air to breathe must be supplied constantly to the occupants and the impure air must be removed. Evidently a system giving a forced circulation of air is necessary to meet these requirements. A good example of this system is the recent installation in the new Franklin Square Theater at Worcester, Mass. The heating and ventilating apparatus consists of an electrically-driven fan and heating coils, located in a corner of the basement. Fresh air is drawn from the outside and circulated through coils of steam pipes inclosed in a fire-proof casing and distributed through ducts by means of the fan to the desired parts of the theater. There are plenum chambers under the orchestra floor and first balcony from which air is admitted through openings in the chair legs, giving an even distribution throughout the house. The low velocity with which the air enters prevents annoyance from draughts. The foul air is exhausted through grills in the dome of the theater and by means of an electric exhaust fan is discharged through the roof. The B. F. Sturtevant Co., of Boston, Mass., were the heating and ventilating engineers, and the apparatus installed is of the Sturtevant manufacture.

ALLOYS OF HIGH TENSILE STRENGTH.*

HERBERT E. FIELD.

The composition 55 per cent. of copper, 42.5 per cent. of zinc and .5 per cent. of tin, which is used under various names, makes a very strong bronze when properly mixed. The strength given by Prof. Thurston is, however, too high for the mixture when it is used in practical work. Prof. Thurston's results, if I remember correctly, were obtained in laboratory experiments; very small amounts of the metal were melted and in this way the temperatures and mixtures were very accurately regulated and to an extent not possible in commercial practice. The test bars made by Prof. Thurston were, I believe, cast in small iron molds, which greatly increases the strength of some bronzes—if not of all, as will be explained later in the discussion. The above mixture is given by Prof. Thurston as combining a maximum strength with a maximum elongation. It is very close to the composition specified by the government for the tray castings which form a part of the breech block mechanism of the steel coast-defense mortars. They originally took this mixture from Thurston and their specifications based on his results originally called for a higher strength than it was practical to obtain in foundry work. It was consequently reduced. This mixture will readily serve as a good basis to work on or to approach to. Even when all new metal is used it is difficult to get the exact composition desired in the resulting casting. This is principally due to the rapid oxidation of the zinc which forms a considerable proportion of the mixture. If this oxidation was constant it would be possible to allow for it, but as the oxidation increases as the temperature increases the temperature would have to be kept constant each time the mixture was used, which is not possible in general foundry practice. Again, if scrap is used from the preceding heats a further error creeps in, due to the loss of zinc in the first mixture. If any considerable amount of scrap is used the error will gradually increase until the mixture will, when analyzed, show a decrease in zinc and an increase in the copper and tin.

I have used mixtures with tin up to 1 per cent. and still obtained good results. I would not recommend this, however, if a high elongation is desired. 57 per cent. of copper, 42 per cent. of zinc, and 1 per cent. of tin makes a strong mixture, but the elongation varies greatly, frequently falling below 10 per cent.

The chief difficulty with these mixtures lies in their tendency to form an open crystalline metal which is not homogeneous. When properly mixed and cast, the metal has a uniform close crystalline, or fine grain, structure which appears to be necessary in order to produce a metal of high strength and high elongation. I do not think that the causes of this peculiar appearance have been clearly explained. It most frequently occurs in large masses. A small runner or test bar will frequently have a fine uniform fracture and give a tensile strength 20 per cent. higher than will a specimen turned from a large mass cast from the same ladle. The latter may have the open irregular fracture above referred to. A test bar 1 inch in area and cast in a chill would give a higher strength than the same sized bar cast in sand, which partly accounts for the high results obtained by Prof. Thurston. These two instances indicate that the rate of cooling has a great deal to do with the strength of bronze of this composition. If this difference between large and small sections was always noticed we might say that the mixture was not suited for heavy work. This is not the case, however, and I have seen many large sections with a perfect fracture, with high strength and high elongation.

There are four factors which enter in to make a successful bronze of this composition. First, the composition; second, the purity; third, the temperature to which it is heated; and fourth, the method of mixing.

Composition.—We have already noted that the composition must be kept within fairly uniform limits but that an increase of ½ of 1 per cent. of tin does not affect the strength, but does frequently reduce the elongation.

Purity.—It is absolutely necessary that pure metals be used in making this mixture. The ordinary commercial products contain so much impurity as to make it impossible to obtain a satisfactory bronze of this composition. The metal which causes the most trouble in this respect is zinc. Most of the cheap commercial zincs contain a large percentage of lead. A very small percentage of lead will greatly reduce the strength of this bronze and it is absolutely necessary that the lead be kept down to a trace, if good and uniform results are desired. There are zincs on the market which are practically free from lead. These bring an increased price, but the extra cost is more than repaid by the greater proportion of castings obtained of the required strength. There is a considerable variation in the copper. Just what causes this has not been determined. It is certain, however, that a copper having a relatively high electrical conductivity will give a high tensile strength when used in this mixture. Whether this decrease in strength caused by some brands of copper is due to sulphur, arsenic or some such impurity, I am unable to state. It is, however, a simple matter to have a specimen taken from each lot of copper and tested for conductivity. If this conductivity is high, you can be fairly sure that your trouble does not come from the copper. The tin used is such a small percentage that it is not liable to contain a sufficient amount of impurity to do any harm. It should, however, be free from lead.

Temperature of Heating.—When a bronze is defective in any respect we always hear a great deal about oxidation. We know that oxidation weakens such metal and we also know that the higher a metal is heated, the greater is the tendency to oxidize. It is difficult to determine that this is the exact cause of the variation in this metal; we do know, however, that this bronze must not be overheated. The duller it is cast and still be sound and free from blow-holes, the stronger will the metal be. The decrease in strength, owing to high heating, may be due to three causes. First, crystallization; second, segregation; and third, oxidation. We have noted in the early part of the discussion that weak specimens frequently showed an open crystalline fracture. We also know that the slower a metal cools, the larger will be the crystals. The higher we heat the bronze, the longer will it take to cool, and hence the greater will be the tendency to crystallize. A great deal of attention is now being paid to segregation in studying alloys. By segregation we mean the tendency of one metal to separate out or come together in one part of an alloy. The peculiar irregular appearance which the alloy frequently assumes is attributed by some to the segregation of the tin. I have seen specimens of this bronze in which a sufficient amount of tin has collected in one spot to make it possible to get a sample which showed upon analysis that it contained several times as much tin as did the surrounding bronze. It is a difficult matter to determine whether the very small particles which appear to destroy the homogeneous structure of this bronze is due to this cause or not. The fact that the tin does occasionally segregate in sufficient amounts to be analyzed would indicate that there was some ground for assuming that this was the case. We know that slow cooling is necessary to segregation. We have noted that the higher the bronze is heated, the slower will it be in cooling and consequently the greater will be the opportunity for the tin to segregate. This forms one more argument in favor of casting the metal at as low a temperature as possible. We find that a small percentage of aluminum added to this mixture frequently improves it and adds to its strength. The aluminum is supposed to act as a deoxidizing agent and the improvement in strength may be due to the fact that the metal has been deoxidized by the aluminum. A very small piece of metallic phosphorus added to the metal improves it, provided it is not added in sufficient quantities to leave any of the phosphorus in the bronze. It is a difficult matter to know just how much to add. An excess is worse than none at all. Aluminum, however, is preferable, as it is easier to add and a slight excess does not seem to harm the metal.

Method of Mixing.—The one point to be kept in mind in

* Written in answer to a correspondent who has had trouble in securing a strong composition by using Dr. R. H. Thurston's well-known formula of 55 per cent. copper, 42.5 per cent. zinc and .5 per cent. tin. According to Thurston this should have a tensile strength of 68,000 pounds per square inch.—EDITOR.

melting and mixing this alloy is not to overheat it. There are two methods which give satisfactory results. If all new metal is to be used the copper should be melted first; when it is melted, it should be cooled down as much as possible before the zinc and tin are added. The mixture must be well stirred with a carbon stick and when at the correct temperature for pouring, the aluminum should be added, and the mixture stirred and poured at once. If scrap from the previous heats is available, the copper may be melted first and the scrap added to reduce the temperature before the zinc and tin are added, or the scrap may be melted and the copper added as soon as it is melted. The zinc should be added while the metal is still at a comparatively low temperature. The former is the safer method, as the scrap serves to decrease the temperature of the copper before the zinc is added. The second is the quicker way, as the bath of melted scrap hastens the melting of the copper. The disadvantage lies in keeping the bath of melted scrap with its high percentage of zinc in the melted condition for a longer time, and hence giving more time for it to oxidize.

In conclusion I would say that it is not possible to obtain 68,000 pounds to the square inch with any regularity; 50,000 pounds is as high as can be expected of specimens cast from this mixture. In order to obtain this, great care must be taken with the details mentioned above. The most important of these are: First, to us pure material; second, not to overheat the metal; and third, to add aluminum if necessary.

* * *

MOTOR DRIVES FOR HARTNESS FLAT-TURRET LATHE.

The illustration, Fig. 1, shows a Jones & Lamson lathe equipped with a Crocker-Wheeler motor operating on the multiple voltage system. The motor has a capacity of 5 horse power at 1,100 revolutions per minute and 240 volts and is mounted directly over the spindle, which it drives by means of a Renold silent chain. Beneath the spindle is placed the regular back-gear, and, when required for large diameter work, a triple back-gear is placed below the regular one. The gears are thrown in or out of operation by friction clutches so that it is not necessary to stop running while

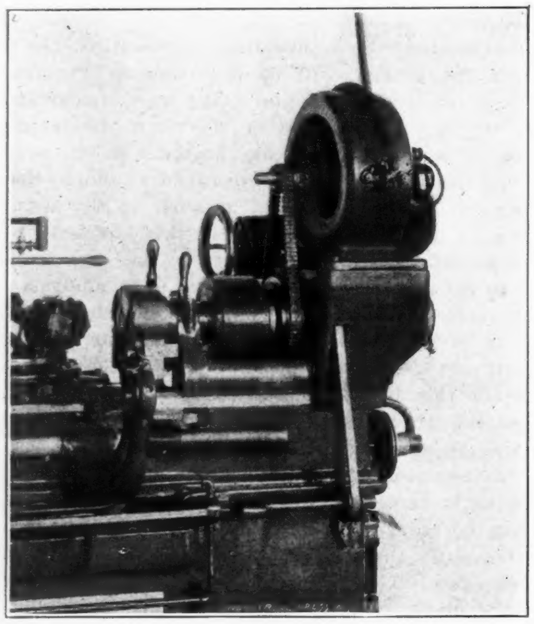


Fig. 1. Jones & Lamson Lathe Driven by Crocker-Wheeler Motor.

making the change. From the motor to the sprocket on the spindle there is a 3 to 1 speed reduction; the first back-gear reduces again by a ratio of 4 to 1 and the second gives 16 to 1 from sprocket to spindle. The motor being supplied with current on the 4-wire multiple voltage system, of the Crocker-Wheeler Company, is capable of six speeds by the separate voltages and six more by the use of one resistance, or twelve in all in either direction. The highest speed is 1,100, which transmitted direct to the spindle turns the latter at about 370 revolutions per minute. The motor's slowest speed, 162 turns per minute, communicated through triple back-gear, makes the slowest speed of the spindle 3 1-3 revolutions. Between these limits there is a total of 36 different speeds in direct or reverse rotation.

Lathe Driven by Northern Electrical Motor.

Another motor attachment for the Jones & Lamson lathe is shown in Fig. 2. The motor was supplied by the Northern Electrical Manufacturing Company, Madison, Wis. It is of

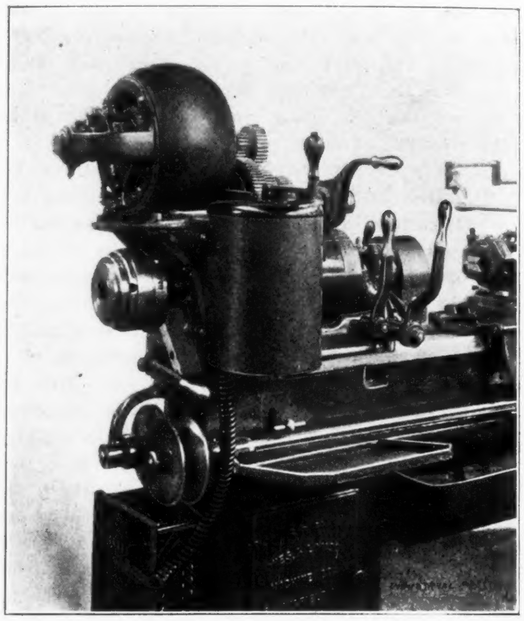


Fig. 2. Jones & Lamson Lathe Driven by Northern Electrical Motor.

the shunt reversible type, for 220-volt current, and designed to run at from 600 to 1,200 revolutions per minute. A Cutler-Hammer drum type controller is used.

In Fig. 3 is a diagram showing the clutch and gear connections between the motor shaft and the lathe spindle. Power is transmitted through the shaft *E* and quill *C*, on which the intermediate gears *A*, *A* and *D*, and the cone clutches *B*, *B*, are located. The quill and shaft turn together, but the shaft slides in the quill and by this means operates the taper cones *B*, *B*, which cause the power to be taken from the motor

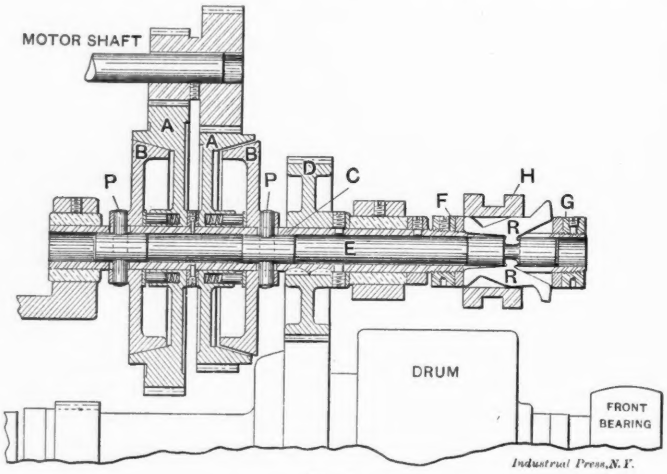


Fig. 3.

shaft by one or the other of the two gears *A*, *A*, according to which cone is in contact with its gear. Pins *P*, *P*, lock the cones positively to the shaft *E*, but longitudinal slots in the quill, through which the pins extend, allow the sliding motion of the shaft and pins, necessary to operate the clutches. Power is finally transmitted to the lathe spindle through gear *D*. The spindle thus has two mechanical speed changes, besides the changes due to the controller, and the back gears of the lathe.

The endwise movement of shaft *E* is obtained through the sliding collar *H* and the two cam rockers *R*, *R*. These rockers are held in place in slots in a collar surrounding the quill previously referred to, and both the collar and rockers are

prevented from having an endwise motion by the collars F and G, which are threaded to the quill. The rockers are pivoted in an annular groove in shaft E, and the movement of collar H in one direction first tilts the rockers, moving shaft E, and then further movement of the collar locks the rockers in one extreme position. Movement of the collar in the opposite direction tilts the rockers the other way, moving the shaft in the opposite direction, and finally locks the rockers in the other extreme position. The spring pins shown in the hubs of the clutches are employed to assist in the release of the cones from their seats in gears A, A.

* * *

ITEMS OF MECHANICAL INTEREST.

GAS SOLDERING IRON—VARIABLE-THROW PUMP FOR LATHE—THE FETTE COTTER DRILL AND SCREW TAP.

At the recent meeting of milling machine manufacturers held at Buffalo, action was taken on the question of standardizing the length of feeds on milling machines. The tendency of the past toward increasing range beyond the legitimate requirements of the market, in order to meet competition or gain a temporary selling advantage, was deprecated and a maximum limit for length of feeds on equivalent sizes of machines was unanimously adopted.

The largest guillotine shear ever built by the Hilles & Jones Co. was recently installed in the warehouse of Joseph T. Ryerson & Son, Chicago. The upper blade is 13 feet 2 inches long and will shear a plate 1½ inches thick and 12 feet long, working between the housings. The overhang or gap is 36 inches, which feature permits a strip 36 inches wide or less to be sheared from the side of a plate of any length, the plate, of course, being moved along parallel with the blade after each stroke. The shear complete weighs 220,000 pounds. It is d riven by a 50 horse power Westinghouse three-phase motor, direct connected by gearing and a friction clutch. The frame stands 21 feet above the floor and the total width is 22 feet.

A method for making a brown print from a blue print is given by W. Allen Bartels in *Engineering News*. His directions are as follows: Make a solution of 9 fluid ounces of water and 1 fluid ounce of strong ammonia. Saturate the blue print with this solution until the blue fades away, leaving white paper, then, after rinsing, apply with a sponge or by immersion the following solution:

Water ....12½ oz. (fluid)
Tannic acid .... 2 drachms = 120 grains

The print will then become a dark brown in about 10 or 15 minutes. This has been found a very satisfactory method of getting brown prints with ordinary blue print paper, where the results pay for the labor involved.

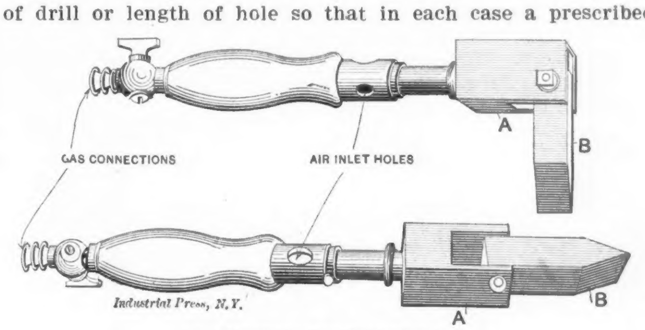
The use of electromagnets in iron and steel works for handling heavy ingots, boiler plates, billets, etc., is one of the applications of the electric current with which we have been familiarized during the past few years. But undoubtedly the humbler electromagnetic cloth pressing outfit for tailors' use is an electric apparatus very few have heard of so far. We are assured by the *Western Electrician* that a Chicago concern, mindful of the hard work imposed on the presser, has brought out such a device which is said to be quite effective for the purpose designed. It consists of two iron bars 24 inches long, 5 inches wide and 1 inch thick, set on edge and placed side by side about 4 inches apart. These bars are connected near their ends by iron cores bearing the magnet coils. When these are energized the edges of the bars become the poles of a powerful magnet. The pressing board is laid on the bars and the tailor's goose acts as an armature, being attracted downward with a force of several hundred pounds. A thumb switch on the goose enables the presser to apply and release the pressure as required.

GAS SOLDERING IRON.

The United States consul at Chemnitz, Germany, describes an alleged novelty recently placed upon the Berlin market in the shape of an adjustable gas soldering iron. The copper bit is movable and can be adjusted at any angle. The consul states that by virtue of this construction the new (?) iron is of great convenience in soldering metallic edges so located as to be difficult of access. The heat generated by the gas flame (Bunsen burner) is utilized to its fullest extent in that the hollow part, A, prevents rapid radiation and concentrates the heat upon the copper bit, B. This system of heating develops a sufficiently high temperature to permit of the employment of a comparatively small piece of copper in the bit and also economizes in the amount of gas consumed. It is reported that a soldering iron of this kind which does the work of an ordinary soldering iron possessing a copper bit weighing 1¾ pounds consumes but 3.6 cubic feet of gas per hour, which, according to the prevailing price of gas in Berlin, represents a cost of from 3 to 5 cents per ten hours.

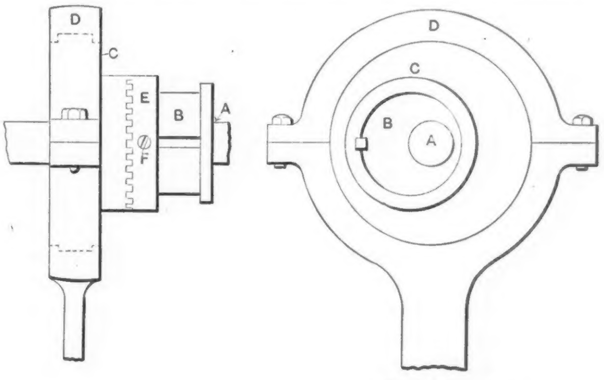
VARIABLE-THROW PUMP FOR DRILLING LATHE.

The Bradford Machine Tool Co., Cincinnati, O., have a somewhat interesting adjunct to a lathe used in their shop for boring lathe spindles, in the shape of an oil-pump having a variable-throw eccentric by which the stroke of the piston may be changed to suit the size of drill and length. That is, the stroke may be adjusted to suit each size of drill or length of hole so that in each case a prescribed flow of oil shall be positively forced to the point of the drill to lubricate it and to clear out the chips. It is obvious that the resistance to the flow of oil is greater with a long drill working in a deep hole than it is with a short drill of the same diameter working in a shallow hole. Again the tubes let into the side of the drill to convey the oil to the point should vary somewhat with the size of the drill, in order to provide a greater volume of oil as the drills increase in diameter.



An Adjustable Gas Soldering Iron.

The accompanying sketch shows the construction of the eccentric. It is really a compound eccentric consisting of two eccentrics, B and C, one inside of the other. Say that both have the same throw, then when the extreme throw of one is opposite that of the other, as indicated in the sketch, the motion communicated to the piston is zero. On the other hand, when C is shifted 180 degrees relatively to B, the motion communicated to the piston is double the throw of each eccentric. Say that the throw of B and C is, in each case, 1 inch, then with the eccentric centers on the same side of the shaft and in the same radial line, the motion communicated to the piston is 2 inches. Intermediate positions would give a stroke varying from 2 inches to zero. The eccentric, B, which is keyed to shaft, A, is elongated with a boss of the



Variable-throw Pump Eccentric.

same diameter extending to the right. The eccentric *C* surrounds *B* and has a boss extending to the right, which is milled across the end for square clutch teeth. The sleeve, *E*, has corresponding teeth and has a keyway sliding upon the feather set in *B*. When the clutch teeth are engaged the two eccentrics are locked together and give a movement depending upon their relative position. By loosening the setscrew, *F*, the sleeve, *E*, may be disengaged and any required adjustment made. The sleeve and boss are marked, one with a datum line and the other with the sizes of the drills. Now if a 1¾-inch drill is to be used the operator sets the eccentrics so that the datum line is opposite 1¾. Of course the different settings have all been determined by experiment. Change gears are also provided so that the speed of the pump may be varied for cases not covered by the adjustment just described.

THE FETTE COTTER DRILL AND SCREW TAP.

Our attention has been called to samples of the Fette cotter-drill by Messrs. Prescott and Bryant, who own the United States rights for it and the Fette screw tap. Both these tools are the invention of a German, Mr. Heinrich W. A. Fette, Altona-Ottensen, Germany, and were patented in the United States about two years ago. The Fette cotter-drills are being quite extensively used abroad, especially in Germany where such firms as the Gasmotorenfabrik, Deutz; F. Krupp, Essen; General Electric Co., Berlin; Actien-Gesellschaft, Weser, Bremen, and others have taken it up.

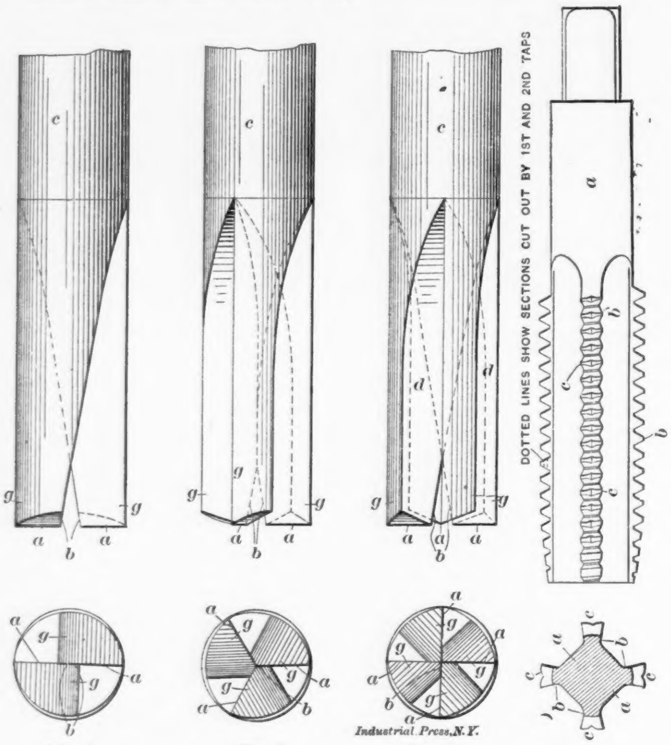


Fig. 1. Fig. 2. Fig. 3. Fig. 4.

At first glance the Fette cotter-drill shown with two, three and four cutting lips in Figs. 1, 2 and 3, seems not essentially different from similar tools used in American practice for key-seating, but on closer inspection of its construction we do not recall having ever seen one working on the same principle. This tool clears away the central teat as it feeds downward independently of any side motion and for this reason can be used as a drill, either for starting its own cut or for other purposes. Fig. 1 shows the tool in its simplest form. It is divided into the longitudinal arms *g* by the grooves *d*, which are cut so that one face of each is parallel with the axis and constitutes the cutting edges *a*. The other side is cut at an angle so that the grooves gradually widen toward the point. This widening of the grooves is such that at the base the core is entirely removed, leaving a triangular space with inner cutting edges, *b*. The ends of *g* are backed off in the usual manner; also the periphery, so as to cut sideways, thus making both a side-cutting and an end mill. When the tool is made with two cutting faces, the grooves are approximately 90 degrees; with three faces, 60 degrees; and with four faces, 45 degrees. When made with more teeth only two of the flutes are carried to the center so as to form the triangular space *b*, the others being made shallow and of the usual form for side-cutting mills. We are informed that these have been made up to 3 inches diameter and that cutters of this size are successfully used by Krupp.

The Fette screw tap requires little description, the cut, Fig. 4, showing the principle quite clearly. It is made in sets of three for hand taps, but they differ from those used in American practice in that the first tap cuts out the base of the thread only; the second tap takes out still more, making a section of the thread a still higher truncated cone section; and the third tap finishes the thread. They are made with four grooves with four rows of teeth as narrow as possible in order to afford a slight elasticity (?). Each set of teeth has a groove, *c*, extending the full length so that each tooth is backed off in both directions toward the groove *c* and as both faces of a tooth are of the same diameter and are sharp, the tap cuts as freely when turned backward as when being screwed into a hole. In this way it is claimed that the breaking of teeth is lessened and the tap made to cut more freely. Further information may be obtained from J. L. Prescott & Co., Paterson, N. J.

DREDGING OPERATIONS BY THE U. S. GOVERNMENT.

An indication of the large amount of river and harbor improvement work now under way or contemplated by the United States Government is given by the fact that at present ten suction dredges are being built, two of which will be sent to the Great Lakes, two to New York harbor, two to the Mississippi River, two to Charleston, S. C., one to Galveston, and one to Savannah, Ga. Five of these are being constructed by the Maryland Steel Co.; two by the James Reilly Repair & Supply Co.; and one each by the W. R. Trigg Co., the Petersburg Iron Works Co. and the New York Ship Building Co.

The mechanical equipment of the dredges for salt-water service will include surface condenser outfits, with Blake air pumps, feed pumps, fire pumps, etc. The dredges for the Great Lakes are provided with very large Blake cross-compound, double-acting air pumps and jet condensers, with the usual complement of Blake vertical duplex feed pumps, fire pumps, etc. The air pumps are of a very novel arrangement, inasmuch as it is possible by the manipulation of valves and cocks provided for the purpose to cut each pump in half and run one side entirely independent of the other side. This practically provides a spare pump in each installation without the necessity of being overweighted with two duplicate machines, and at the same time secures the advantages of compound steam cylinders.

These dredges are the largest in capacity ever built, and are designed in each case for the special work which they will have to do. They are self-propelling, sea-going dredges, and do not depend upon the assistance of tugboats or other craft to move them around from point to point. Some of these vessels are fitted with immense bins, in which the dredged material is deposited, and when full the vessel propels herself out to deep water, dumps the sand or mud and steams back to repeat the operation. Others are arranged for depositing the dredged material into large scows fastened alongside the vessel.

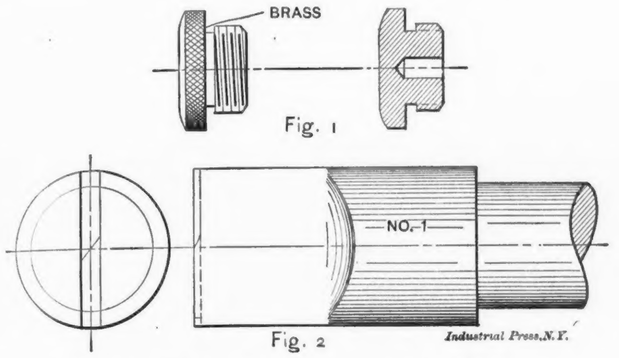
The operation of these machines is very interesting. A long flexible tube 12 to 15 inches in diameter drops down from the side of the vessel 20 to 30 feet or more to the bottom of the river or harbor upon which the dredging operation is being performed. The upper end of this tube is connected to an immense rotative centrifugal pump revolving at several hundred revolutions per minute and capable of handling many hundreds of tons of water per hour. The lower end of the tube is manipulated from the vessel against the sand bars and mud banks, and as the water is sucked upwards by the centrifugal pumps a very large proportion of sand and mud goes with it. The centrifugal pumps discharge this water with its suspended material into the tanks on board the vessel or into the scows, where the heavy matter quickly settles to the bottom, the water flowing back into the sea.

LETTERS UPON PRACTICAL SUBJECTS.

AUTOMATIC LATHE TOOLS FOR MAKING A BRASS OIL BOTTLE STOPPER.

Editor MACHINERY:

The accompanying cuts show some English automatic lathe tools for making a brass oil bottle stopper, having a hole drilled in the center for a spoon made of wire. Fig. 1 shows the stopper—a simple piece. Figs. 2, 3 and 4 show the tools.



Figs. 1 and 2. Brass Stopper and Facing Tool.

The facing tool, Fig. 2, the drill, Fig. 4, and the threading die are used in the main turret; and the forming and cutting-off tools are fixed on the small turret, Fig. 3. This turret is mounted on the cross-slide.

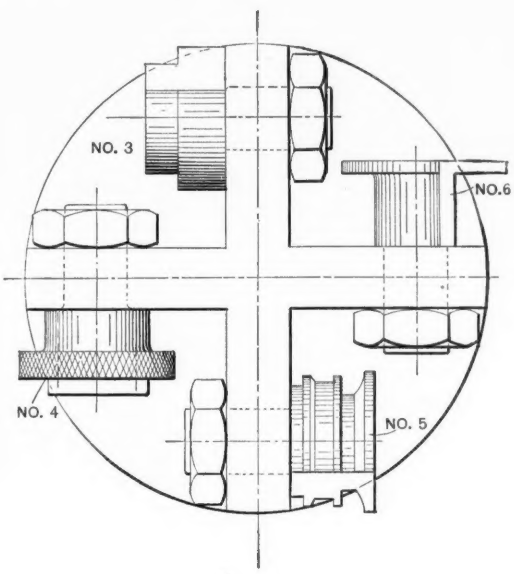


Fig. 3. Turret for Holding the Forming and Cutting-off Tools.

The order in which the tools work is as follows: First operation, No. 1 tool; second operation, No. 3 tool; third operation, Nos. 2 and 4 tools; fourth operation, No. 5 tool; fifth operation, threading; sixth operation, No. 6 tool.

The rate of manufacture of the stoppers with this outfit is about 70 pieces per hour. CHARGE HAND.

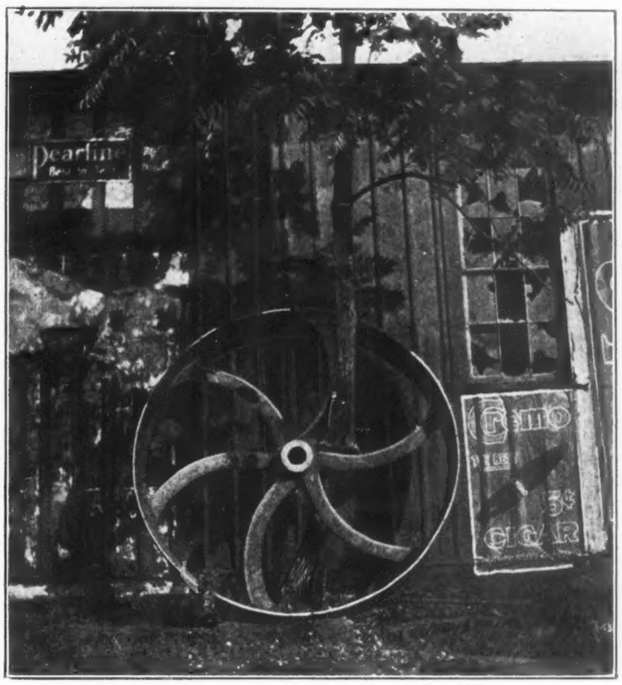
ANCHORED.

Editor MACHINERY:

I send you herewith a photograph that may interest you and your readers. The pulley is 8 feet diameter and 12 inches face. The tree is 12 inches diameter at the butt and is probably forty years old, or more. How the old pulley has escaped the junk man so long is a mystery. J. F. WILLEY.

Jeffersonville, Ind.

[We might say that it is also a mystery why cast-iron scrap of this character is allowed to accumulate around many shops,



An Old Timer.

were it not that it seems to be a common characteristic of too many shop owners to vaguely anticipate some future use for such material. If this pulley, which probably weighs about 1,000 pounds, had been sold forty years ago at one-half cent a pound, the compound interest at 5 per cent. alone would have amounted to over $35, to say nothing, in that event, of its not spoiling what probably would have been a shapely tree!—EDITOR.]

RE DEEP HOLE DRILLING.

Editor MACHINERY:

In the January, 1904, number of MACHINERY, we notice an article by Frank B. Kleinhans, entitled "Deep Drilling." We respectfully call your attention to the fact that the writer of the article gives no credit for the design of the special drill described and makes no reference to the shop where used. This he should by all means have done, especially since he is acquainted with the long series of experiments attending the development of the tool. This drill was developed in the

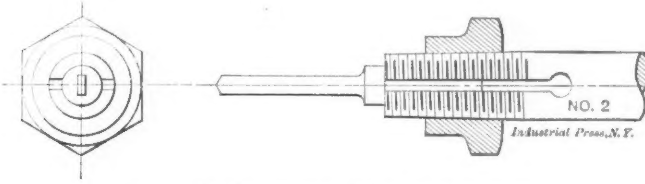


Fig. 4. Drill for Drilling Hole in Brass Stopper.

shops of the well-known lathe builder, the Lodge & Shipley Machine Tool Co., of Cincinnati, O., and is the outgrowth of the wide, practical experience of their superintendent, Mr. N. D. Chard.

Further, steps are being taken for the proper protection of the design by letters patent, and the Three Rivers Tool Co. have arranged with the Lodge & Shipley Mch. Tool Co. for

the exclusive right to manufacture and sell this drill. We are giving to the tool the name of "The Get-There Spindle Drill." Before long we shall be on the market with this and other "Get There" specialties in the small tool line.

THREE RIVERS TOOL CO.,
per J. G. Matthews.

AN EXPANSION BUSHING ARBOR.

Editor MACHINERY:

Having a lot of bevel gears to cut on the milling machine, the fact that all were bored to different sizes seemed to require a special arbor for each size of gear, but we were able to save most of this expense by designing and using the expansion bushing arbor that is shown in the accompanying sketch. The shank of this arbor, *A*, was fitted to the dividing head and bored with ½-inch hole, at the bottom of which was a threaded portion *B*. The front end was also bored out and a fine thread cut at *D* for receiving the various sizes of expansion bushings, one of which is shown at *E*. These bushings were bored tapering and four slots were cut from the end to the holes at *F*.

After a gear is placed upon this bushing, the screw *G* is tightened and the bushing thereby expanded, so that it holds the blank firmly in place. This arbor may be used for any number of different sizes of holes, the only requisite being to make a bushing to fit each size. This bushing is screwed in and out of the end of the arbor by means of a spanner wrench. An external thread is cut on the front end of the shank so that a nut can be used for easily withdrawing the arbor from the dividing head.

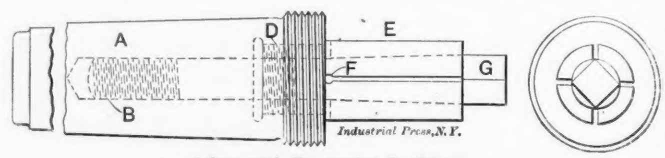
ALBERT ELMIGER.

Dayton, Ky.

A LATHE TAPER ATTACHMENT.

Editor MACHINERY:

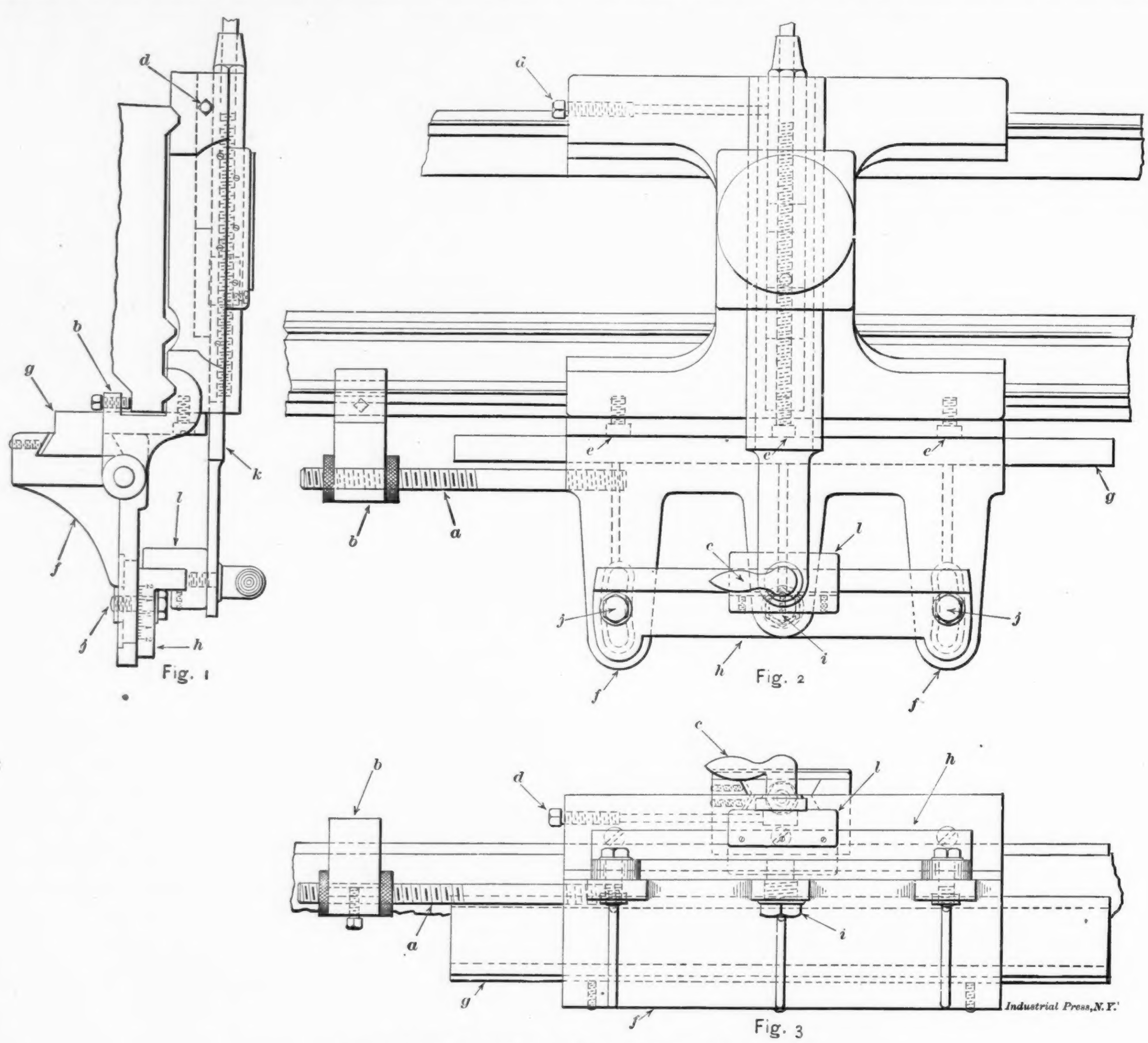
Upon receiving a very large order one day for all kinds of tapers to be turned and bored in the lathe, and having no taper attachment to any of the lathes, it was suggested to build one rather than turn the order away. This was at first thought to be a rather expensive undertaking, but it was decided to try, and after it had been built and put in use, the



Arbor with Expansion Bushings.

outlay of time and money was never regretted. I believe a description of its construction may be of good use to some of your worthy readers (for what helps one may help others), and after coming before the public it may yet be further improved. It has so far proved very satisfactory for all of the work wherever it has been tested.

The assembled drawing of the attachment is shown in three views, Figs. 1, 2 and 3. It is fastened directly to the carriage in the rear, therefore is always in position and ready for use. It travels the entire length with the carriage, as will be seen at the left of the top or plan view, Fig. 2. The connection with the bed is through the screw *a* and the clamp *b*. It is only necessary to tighten the clamp *b* and loosen the screw *d* to turn the work tapered, and *vice versa*, to turn it straight. In either case the binding handle *c* or the screw *d* is not removed.



Figs. 1, 2 and 3. Details of a Taper Attachment for the Lathe.

The attachment is fastened with three screws *e e e* in the rear of the carriage, and projects down so as to be in alignment with the cross-slide. The table *f* slides on the hanger *g* and is provided with a jib to take up whatever wear that may occur. To the table is fastened the arm *h* which turns on the bolt *i*. When the proper taper is obtained, it is held securely in position with two screws *j j*. On this arm slides the piece *l* which is also provided with a gib, and this piece receives the handle *c*, which binds the cross-slide *k*. The top of the carriage is planed across to receive the double-acting slide *k*, and this is provided with a clamping device by means of which it can be fastened at any desired position along the cross-slide. At the bottom of this slide is left a hub about 6 inches long, and 1½ inch wide, to act as a solid wall for the screw *d* which binds it.

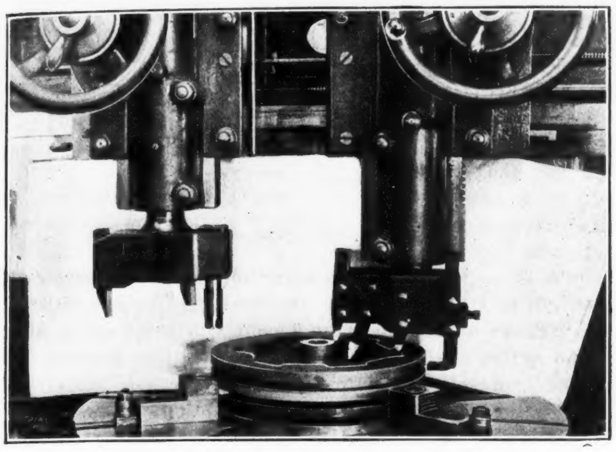


Fig. 1. Tools in Position for Facing, and Turning Packing Groove.

The tool slide is interchangeable with a compound rest, and can be moved independently of the taper slide, and will thus not interfere with the lathe for ordinary purposes. The old-style attachment cannot be moved in connection with the carriage. But as this device makes it possible to move both simultaneously by simply loosening the clamp and thus using

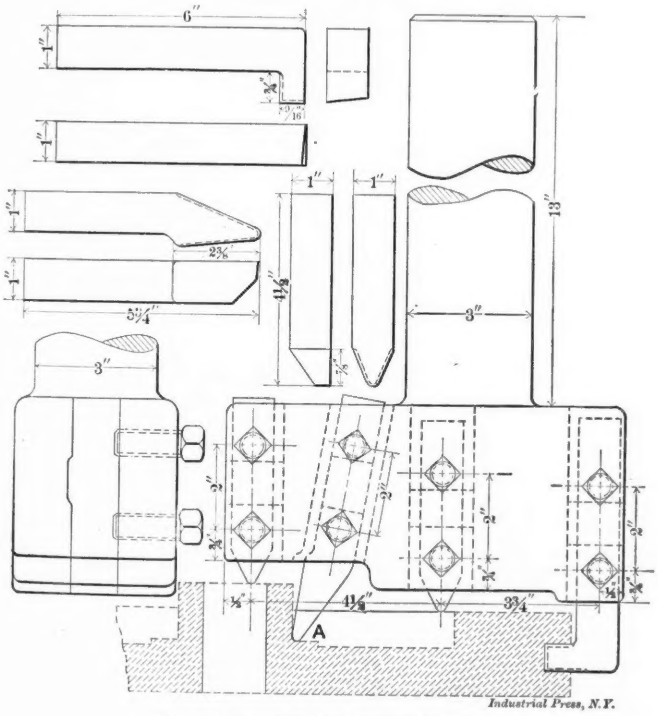


Fig. 2. Details of Tool shown in Fig. 1.

it on any part of the lathe, the problem which has so long troubled lathe manufacturers is solved. The simplicity in construction, its wide range of adjustability and the ease with which it can be manipulated, are characteristics which should commend it to the public wherever a lathe is used.

A. L. MONRAD.

New Haven, Conn.

[Perhaps some of the lathe builders will not agree with Mr. Monrad, but may insist that they have already solved the problem on substantially the same lines as outlined above, so far as the general action is concerned.—EDITOR.]

SPECIAL TOOLS FOR THE UPRIGHT BORING MILL.

Editor MACHINERY:

The upright boring mill is usually considered to be indispensable in most manufacturing plants, but, being rather expen-

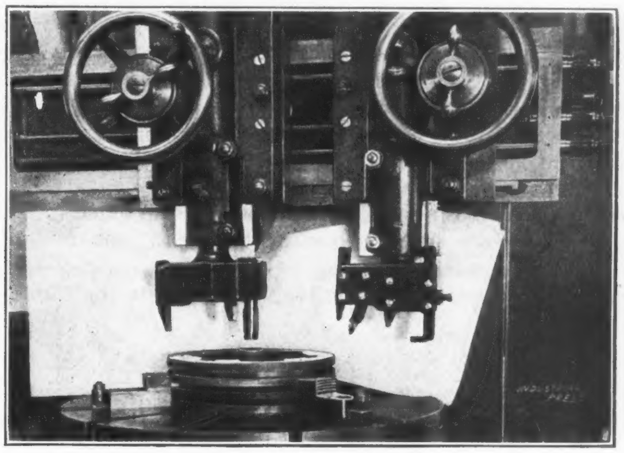


Fig. 3. Showing Tools in Position for Reaming Hole, and Turning.

sive in the matter of first cost, every shop manager naturally desires to obtain a maximum production from it, so that the balance sheet at the end of the year will show a profit from its use. Whenever this tool is used for machining parts in con-

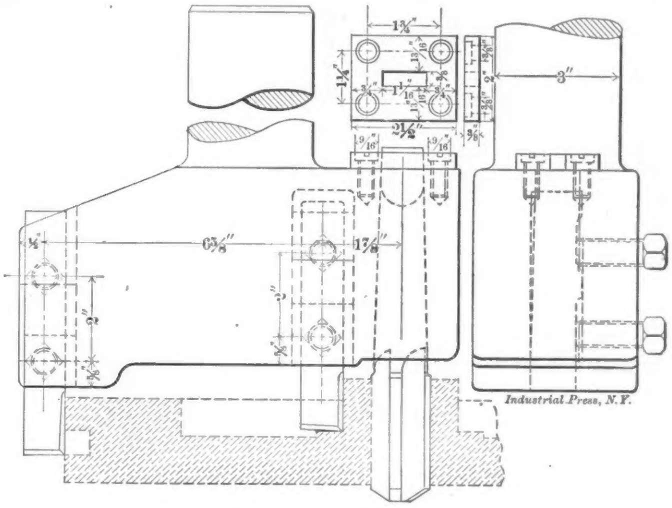


Fig. 4. Details of Tools shown in Fig. 3

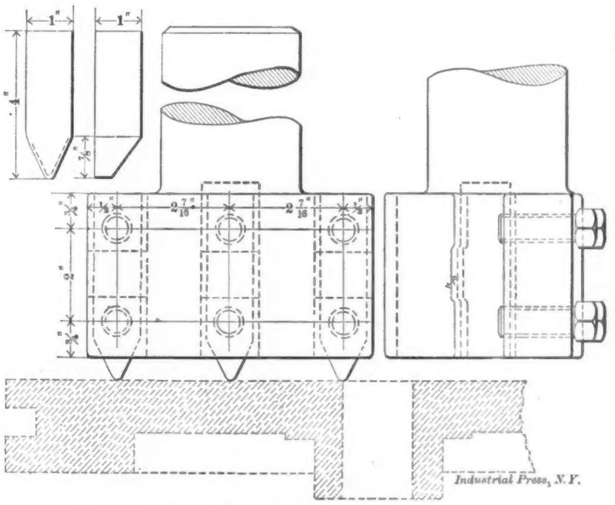


Fig. 5. Multiple Tool for Facing.

siderable quantities it is generally good practice to design a few tools or jigs with the object of producing the parts in the shortest possible time. In most cases such tools pay for themselves by the time saved in finishing the first lot.

Along this line the writer submits the cuts and photographs on previous page, illustrating a set of tools which have proved very profitable for finishing the casting that is shown in the photograph on the table of the boring mill. Fig. 1 shows the tools in the first position in which four operations are performed at one time, and while not completing them in one-fourth of the time of the old method (as it was necessary to regulate the cutting speed by the tool turning the largest diameter), the saving was nevertheless much more than 50 per cent. The details of this tool are shown in Fig. 2, in which the work being machined is indicated by dotted lines. The tools are made of Mushet steel, and each is held in place in the head by two ⅝-inch setscrews. This set of tools operates in a horizontal direction, from right to left, and the different tools in their order, face the end of the hub, face the shoulder *A* at the base of the hub, face the top side of the rim and cut the groove around the outside.

In the other tool post is placed another head which carries the tools that are shown in position in Fig. 3, and in detail in Fig. 4. In addition to the two turning tools this head carries an end mill for boring the center hole in the casting.

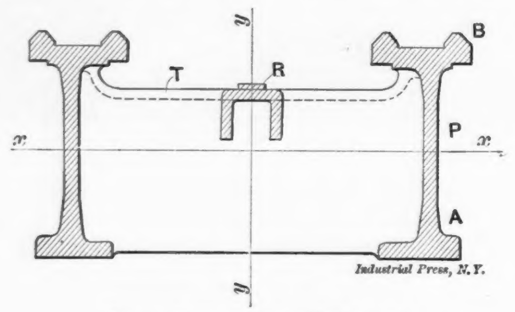


Fig. 1. Cross-section of Lathe Bed.

The operation of these tools is in a vertical direction, the sliding head being set so that the reamer is central with the center of the casting, and then fed downward so that while the hole is being bored by the reamer, the other two tools are turning the outside of the hub and the outside diameter of the piece, thus completing the work on this side of it.

The other side is faced with the multiple tool shown in Fig. 5 which performs the work in one-third of the time formerly required to do it with a single tool. These holders are all simple in construction, of cast iron, being cored for the tools and having their shanks turned to fit the sliding heads of the boring mill. E. E. Wood.

CHATTERING OF LATHES.

Editor MACHINERY:

All lathes chatter more or less under a heavy cut. The magnitude of the chatter depends largely upon the weights, design and construction of the machine. In these days, when

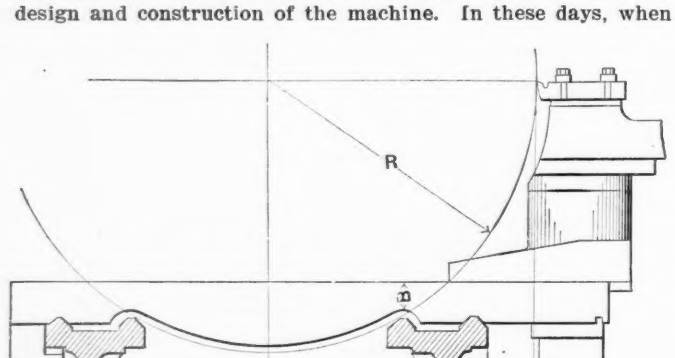


Fig. 2. Overhang of Carriage a Cause of Chattering.

deep cuts and rapid feeds are required, we find tools which chatter almost unbearably, especially on large diameters.

If we wish to take an exceedingly heavy cut, we are, of course, obliged to use a heavy lathe, and this means a lathe with a large swing; for, although the smaller size lathes would swing the work, they do not have sufficient power to handle the heavy cuts. Thus, while a 24-inch lathe would swing a heavy forging 18 inches in diameter, we are obliged to use a 48 or 60-inch lathe for this class of work. Even with lathes of this size, we frequently find that the tool will chatter so much that we are unable to take a cut of sufficient width and depth to stall the machine. In order to prevent chattering we must have a solid bed of great torsional strength. This means that the material should be placed as far from the neutral axis as possible. Thus, in Fig. 1 the portions at *A* and *B* are made heavy, while the plate *P*, which runs the full length of the bed is comparatively thin. The further we keep the metal from the neutral axes *x x* and *y y*, the stiffer the bed will become. The best arrangement for the cross ties *T* is a box section which is open at the bottom. A rack *R* should be cast on another box section and should extend the full length of that part of the bed traversed by the tailstock.

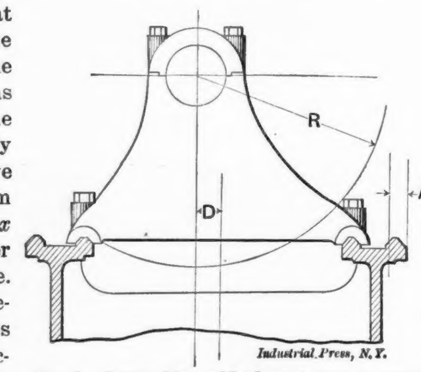


Fig. 3. Center Line of Lathe set over to avoid Carriage Overhang.

Fig. 2 shows a common arrangement of a great many lathes. *R* is the radius of the faceplate. A vertical line dropped from the outside of this faceplate falls a considerable distance, *A*, outside of the line of the bed. On large diameters, therefore, the overhang of the carriage is so much that this portion bends down and we are always sure to have chattering under such conditions. Also on some machines the thickness *B* is made short in order to swing as large a diameter as possible over the carriage. This part being thin, the carriage bends at this point, which action increases the chatter. It is well, therefore, to either make the carriage thicker at *B* or else cut off the V from that side of the bed and build down the carriage to meet it.

If the lathe spindle is thrown back out of the center line of the bed, we can reduce the overhang of the carriage on large

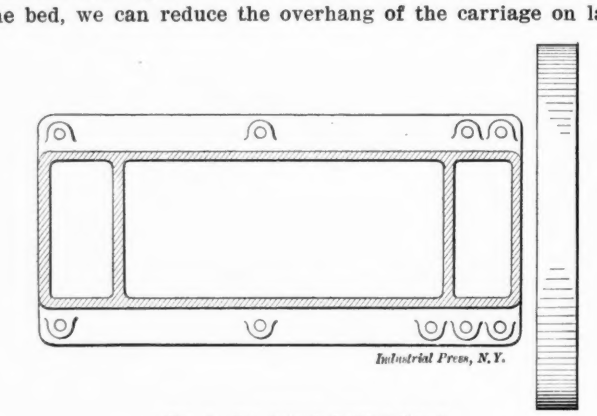


Fig. 4. Headstock Bolting Detail.

diameters. Thus in Fig. 3 we have an end view of a lathe with the center thrown back the distance shown at *D*. A line dropped from the outer end of the radius *R* of the faceplate, falls inside of the line of the bed as shown at *A*. We thus have the downward thrust of the tool on the bed, instead of on the overhang.

Another reason for chattering will be found in the connection between the cap and the headstock and between the headstock and bed. These bolts are almost invariably too light and too few in number. Let us take a lathe with a faceplate pull of 10,000 pounds at its periphery. When we are cutting on a small diameter we are likely to get a thrust on the tool of four times this amount. This, of course, must be resisted by the bolts. If this pull is figured out on many lathes, the bolts will be found to be weak in this particular.

Fig. 4 shows the arrangement of the bolts on a 60-inch lathe of recent design. The bolts were designed so that the fiber stress was not allowed to run above 9,000 pounds per square

inch of section. As the pull is on the front of the center, more bolts were placed on this side, and as the lift is at the faceplate, the bolts were placed near the end, as shown. The bolts in the cap should be figured out in a similar manner, for strength. Every bolt stretches under a load, and the longer the bolt the greater will be the stretch. The bolt should therefore be made as short as possible, both for the cap and for the head.

It should be remembered that when driving a spindle through a back gear there is more or less torsion between the spindle gear and the faceplate. If it is desired to use a lathe for heavy work, therefore, a back-geared lathe should not be used, as it is next to impossible to prevent chattering with such an arrangement of gears. Instead, the lathe should be fitted up with triple gears and be driven from the faceplate, preferably through an internal gear, as this arrangement of gearing gives a smooth, positive movement, with very little chance for torsion.

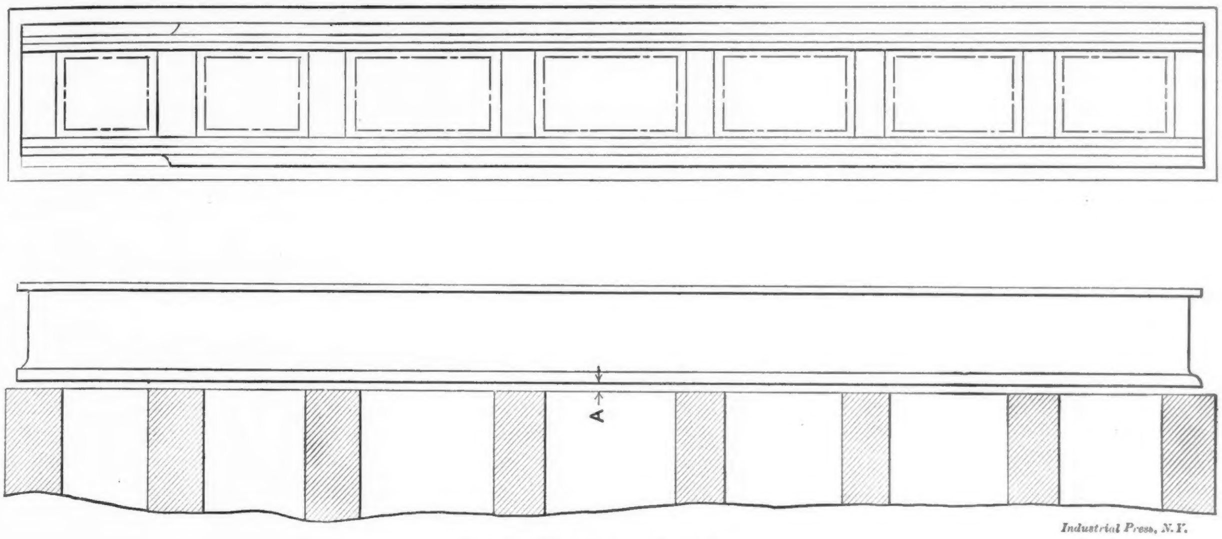
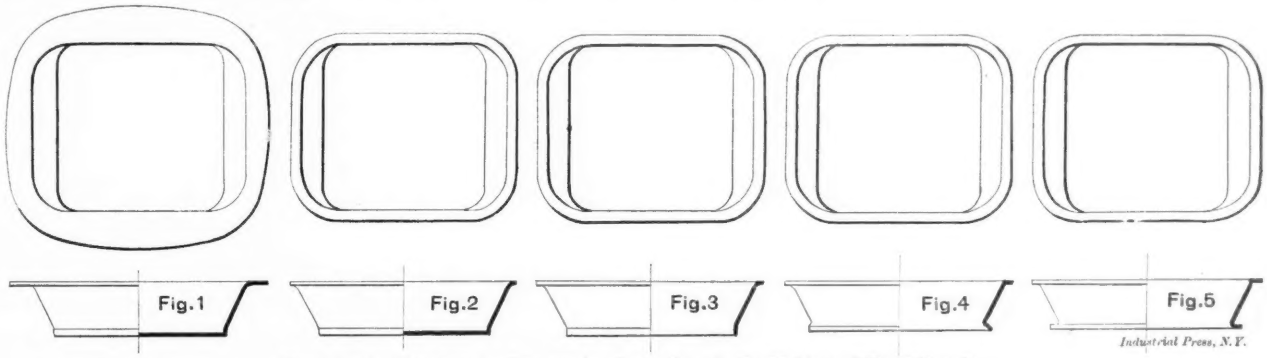


Fig. 5. Lathe Bed and Foundation.

No matter how well a lathe may be designed for heavy work, if it is not properly bolted down to a firm foundation it is almost certain to give trouble. Fig. 5 shows a large lathe bed and foundation. A distance *A* of about one inch is allowed for sulphur or cement. The foundation bolts are conveniently arranged on the inside of the bed and located near the corners. Clamps are then placed across the corners to receive these bolts. After the sulphur or cement has hardened, these bolts should be drawn up tight. There is little chance to spring a bed that is thus properly bolted down on its foundation. If these precautions in the design and in the setting up of a lathe are taken, we are sure to have a machine which will run smooth under the heaviest cuts and be practically free from chatter. FRANK B. KLEINHANS.

Royersford, Pa.



Figs. 1 to 5. Showing the Progressive Operations in the Making of Shunt Spools.

TOOLS FOR MAKING SHUNT SPOOLS.

Editor MACHINERY:

A short time ago we had occasion to produce a number of shunt spools for use in electrical work and the tools by which these were made are illustrated in the accompanying sketches. Figs. 1 to 5 show the progressive operations by which these pieces were made, Fig. 5 being the completed spool. The material used was soft sheet brass .025 inch in thickness. In this particular instance no attempt was made to develop a perfect blank for drawing, or to make a blanking die for cutting the pieces out, as we had in stock a lot of round blanks of the required thickness which were waste material from

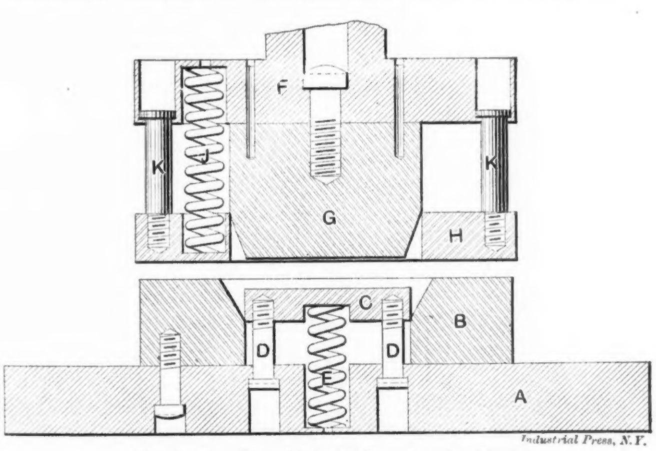


Fig. 6. Punch and Die for Drawing the Blank.

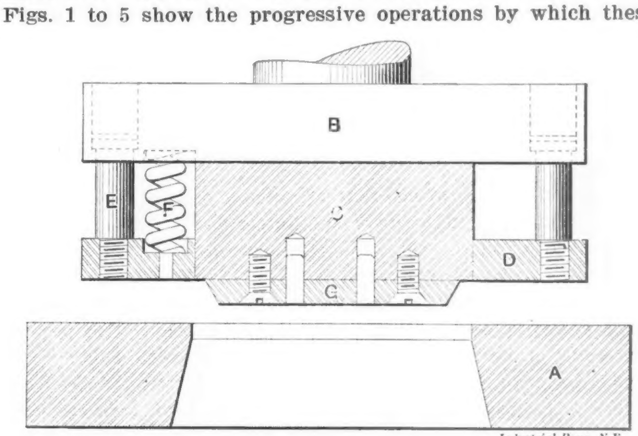


Fig. 7. Punch and Die for Trimming the Blank.

other stampings and proved to be very well suited to our purpose. The tools will be described and illustrated in the order in which they were used.

Fig. 6 shows the punch and die that were used for drawing the blank to the form shown in Fig. 1. The tool steel die *B* was fastened to the cast-iron holder *A* by screws and dowel pins, and the ejector was secured in place and limited in its upward movement by the screws *D*. Beneath the ejector were placed the four springs *E*, which forced it and the blank up and out on the return stroke of the press. To locate the blank in position on the face of the die four pins were driven in the die and a corresponding number of clearance holes were drilled in the blank holder of the punch for them to enter. In the punch, *F* is the holder and *G* the punch proper, while *H* is the blank holder and is made of machine steel and polished on its face. Eight helical springs, *J*, made of 1/8-inch steel wire, were employed to hold the blank and prevent any wrinkling, while the blank holder was held evenly in position by the four screws *K*. This arrangement worked very well, although under ordinary circumstances a rubber cylinder is preferable for holding down the blank holder instead of the springs, but they were used in this case for want of material to do otherwise.

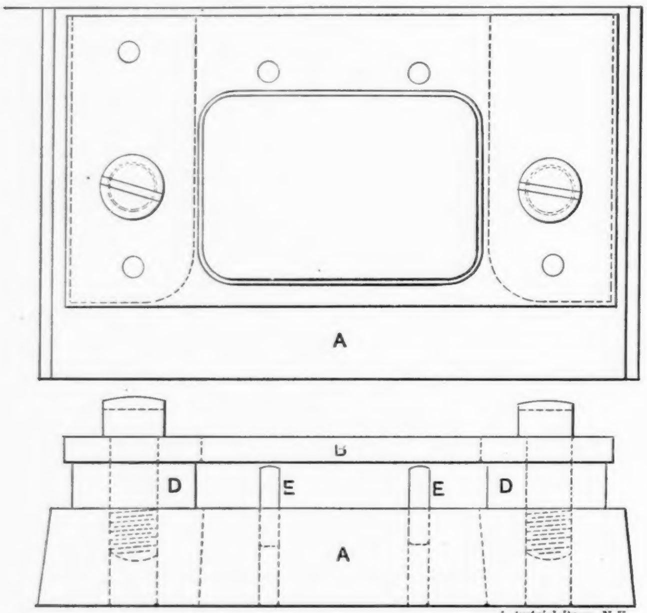


Fig. 8. Plan and Side of Die used for Cutting out Bottom.

After the drawing operation the blanks were trimmed by the punch and die shown in Fig. 7. *A* was a plain blanking die with the hole finished straight for about 1/8 inch, while for the remainder of the distance an extra amount of clearance was given to allow the work to drop through as each piece was trimmed. The punch consisted of the holder *B*, the cutting punch *C*, and the stripper *D*, which was held in place by the four screws *E* and actuated by the springs *F*. *G* was the pilot which entered the trays on the downward stroke of the punch in order to insure an equal flange all around.

For the third operation, that of cutting out the bottom, we used a simple blanking die with the stripper fastened to the die at such a height that the work could easily be slipped beneath it.

The result of this operation is shown in Fig. 3, while Fig. 8 shows a detail of the die that was used. The punch was made of tool steel, properly hardened, with the shank turned down to fit the punch holder. Its cutting edge was made a very good fit in the die so that it would remove the stock evenly from the bottom of the spool. The hole through the die *A* was made slightly tapering and of the shape of the inside of the work. The stripper *B* was supported from the face of the die, at a distance a little greater than the thickness of the spool, by means of the cast iron pieces *D D*, which also formed side guides for placing the work in the die. Two pins *E E* were used for a back stop to prevent pushing the piece too far in.

In operation the work was placed on the face of the die, under the stripper, and the punch descending entered the tray and, passing down into the die, cut the bottom from the tray. The hole in the stripper being only .005 inch larger than the punch readily removed the work from the latter, without any wrinkling, on the return stroke.

The manner in which the flange was turned can be seen from the sectional and plan views of the punch and die in

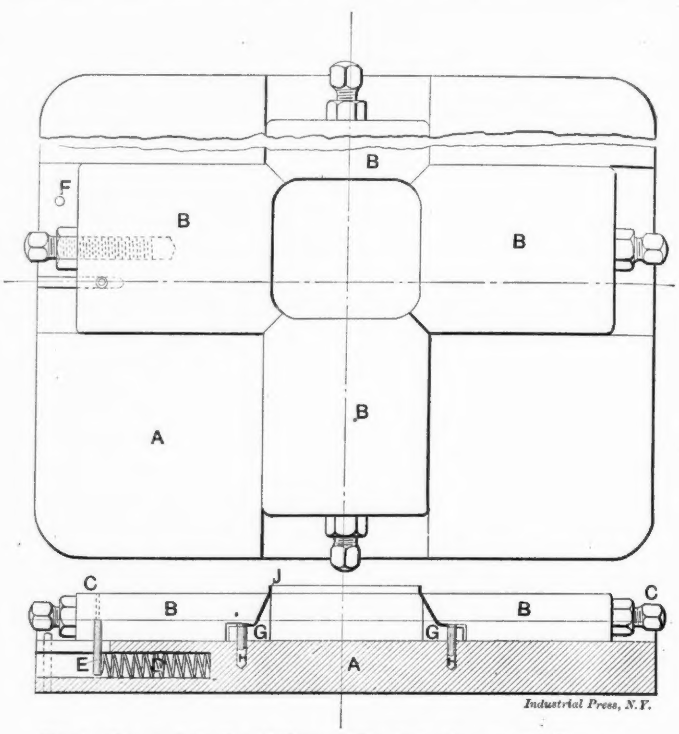


Fig. 9. Plan and Sectional Views of Punch for Turning the Flange.

Figs. 9 and 10. In Fig. 9 the work is shown in position on the die at *J*, being held in place by the locators *G G*. This die is of the automatic slide type, quadruple in action, the slides being moved in and out in unison by means of inclined faced studs fastened to the punch holder, and springs located in the die base. The cast-iron base *A* has two dovetailed channels planed across the top at right angles to form a bearing for the four slides *B B*, each of which is fitted to

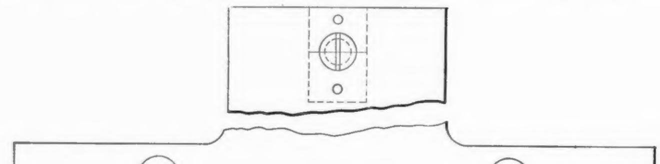


Fig. 10. Plan and Sectional Views of Punch for Turning the Flange.

slide in its respective bearing, the inner ends being so shaped that on coming together they completely surround the tray and also form a surface on which the flange is turned back when the punch descends. A hardened setscrew and check nut *C* is placed in the end of each slide, for adjustment and to engage with the plunger studs. These slides are forced outward by the springs *D* in contact with the pins *E*, while

the pins *F* prevent them from expanding too far. The pins *H H* back up the flanges and check any tendency to spread at this point. The plunger is composed of the four-winged cast-iron holder *K*, Fig. 10, to the end of each arm of which are fastened the inclined studs *L*, and the plunger *M*. Two operations are performed with this punch and die; the first with the flanging punch *M*, which partly turns the flange back as shown in Fig. 4, and the last operation in which the plunger *M* is replaced by the plunger *N*, having a square corner at *R*, and turning the flange squarely back as shown in Fig. 5. An annealing of the lower part of the tray after the bottom was punched out, and between the flanging operations, was necessary to prevent splitting on the outer edge of the flange. C. H. Rowe.

Worcester, Mass.

CAUSE AND EFFECT.

Editor Machinery:

Now and then writers in mechanical papers tell us mechanics how to construct reamers—notably hand reamers. An especial fad seems to be some method of fluting calculated to avoid "chattering," as they tell us. One advocates an odd number of flutes; another an even number, but spaced slightly irregular; while another says spiral fluting remedies the whole trouble. Now it is a fact that reamers with any and all of these methods of spacing the flutes will chatter, or not chatter, according as the real cause is taken account of and guarded against.

What is the primary cause for chattering in the lathe or other machine tools where we use cutting tools? First, too much back rake of cutting tool; and, second, springing of work opposite the cutting tool, allowing it to alternately cut in and jump out. Now in the case of a hand-fluted reamer cut with 10 flutes we have 10 cutting edges, and if the tops of the lands be backed off a considerable amount, that reamer will surely chatter any way you may flute it, because the cause which produces chattering exists therein. But let the tool maker first grind the reamer perfectly round and smooth, and after slightly easing the tops of the lands by the use of an oil stone or other mild means, tone up the front edge to a sharpness sure to cut, and ream your hole, and it is not possible to make that reamer chatter. Don't try to remove a quantity of stock by a finish or size reamer. One-hundredth part of an inch under size for a one-inch diameter reamer is a great plenty of stock to remove; .005 inch is better and avoids much trouble in obtaining a smooth and round hole.

I was employed at one time where they had a full set of hand reamers. Of course, certain sizes used most got dull, and we nick-named them "burnishers," for the reason that they were round and smooth, and though they were dull it was an absolute impossibility to make them chatter in a hole. One day the proprietor took a job of a lot of pieces having a hub requiring a ⅝-inch diameter hole by 3 inches long. He made a preliminary trial with one of these pieces, using his regular ⅝-inch reamer, but it was dull and worked hard, and he remarked that he would have to send for a new ⅝-inch reamer. But I thought I could put it into shape to do the job, and found that by grinding off the front of each land, producing a cutting edge, old "burnisher" did the business smoothly and easily. A notable mechanic of long years of experience tells us that he always grinds his reamers perfectly round and smooth, and to obtain the cutting edge sharpens them by grinding them off in front, and he never has any chattering reamers in his shop. Once any cause is known the remedy is forthcoming. F. W. Clough.

Orange, Mass.

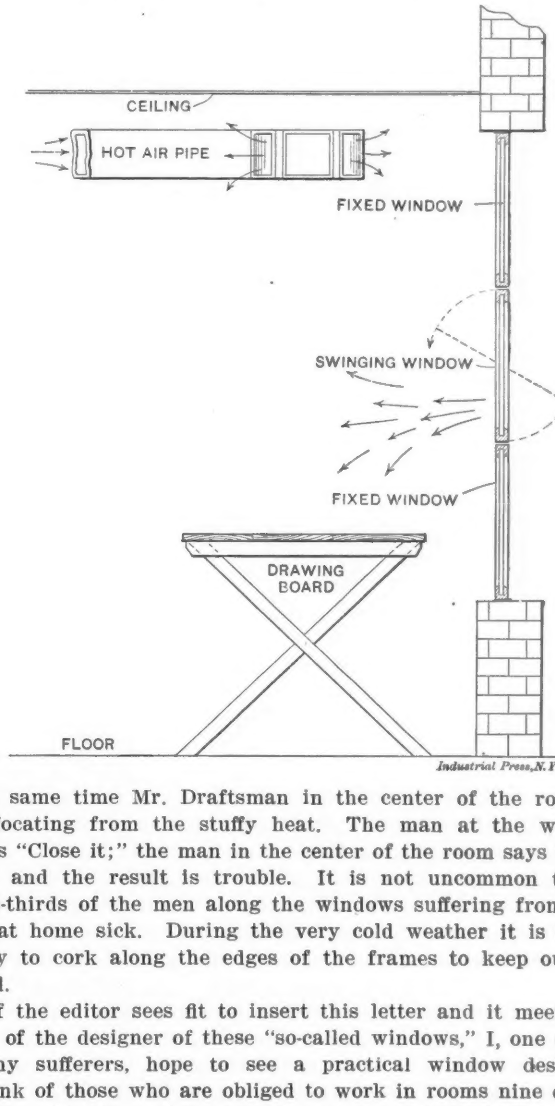
FAULTY CONSTRUCTION OF SHOP WINDOWS.

Editor Machinery:

Looking through some back numbers of Machinery, an article on "Factory Construction" interested me very much; not because I am in the construction business, but that I, as well as others, have been obliged to work in a room where faulty design has hampered my work and injured my health.

The windows are the faulty design I refer to. The company I am employed with keep about fifty draftsmen, and all are located in one large room, heated by the hot-air system. Along the sides near the windows the drawing boards are placed, as many as is convenient; the remainder cover the center of the room. By referring to sketch you will see that the window is about 3 feet from the floor and extends to the ceiling. The bottom and top sections are fixed, and the middle section is hinged at the center, which is the only provision for ventilation. The hot air pipes are close to the ceiling, as are the dampers at the outlet.

In cold weather the heat is turned on until the room becomes too warm. The hot air regulators are high and unhandy to get at, so to cool the room the windows are opened. But the windows being low down, about in line with Mr. Draftsman's head, he very soon finds that he cannot stand the draft blowing on him, and soon closes the window. At



the same time Mr. Draftsman in the center of the room is suffocating from the stuffy heat. The man at the window says "Close it;" the man in the center of the room says "Open it," and the result is trouble. It is not uncommon to see two-thirds of the men along the windows suffering from cold or at home sick. During the very cold weather it is necessary to cork along the edges of the frames to keep out the cold.

If the editor sees fit to insert this letter and it meets the eye of the designer of these "so-called windows," I, one of the many sufferers, hope to see a practical window designed. Think of those who are obliged to work in rooms nine or ten hours with these glass traps! Insurance inspectors are not the only persons in this world.

Draftsman.

* * *

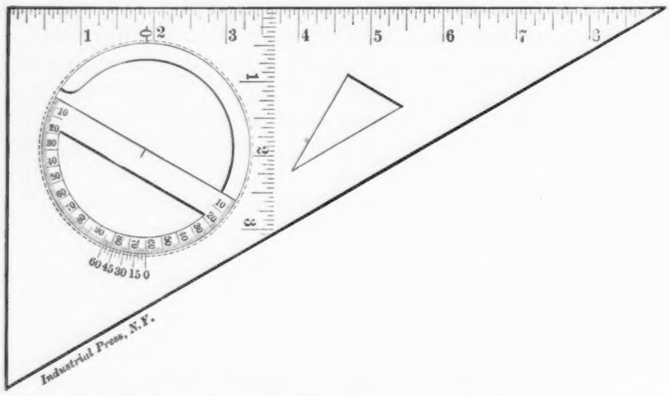
CONTRIBUTED NOTES AND SHOP KINKS.

GRADUATING TAILSTOCKS.

H. A. Mears writes: I have this suggestion to offer anent the somewhat lengthy description of a graduated tailstock spindle which appeared in the August number of Machinery. Instead of going to the trouble of making lines all around the tailstock spindle, I screw the spindle back as far as it will go and make a mark on the side or top flush with the face, then run it out another inch and make another mark. This is continued for the whole length of the spindle and then the divisions are subdivided as desired. This accomplishes the same result without the necessity for removing the spindle from the tailstock. With a sharp pointed tool I have drawn a horizontal center line on the front side of the spindle and find this very handy for setting tools.

COMBINATION TRIANGLE AND PROTRACTOR.

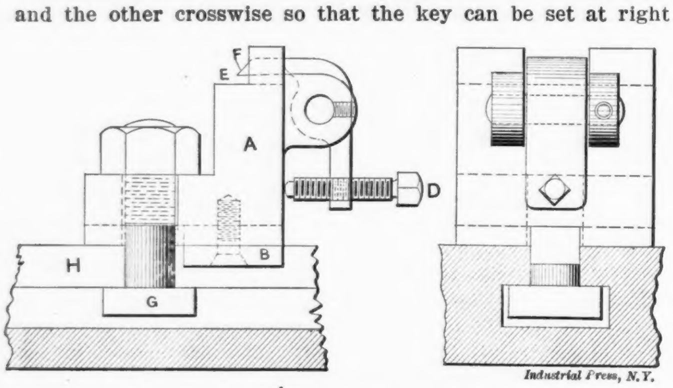
E. A. C. sends us the accompanying sketch of a celluloid triangle which he has constructed, and is finding very handy for drafting room use. The lower side is graduated in sixteenth inches, and by moving the T-square up and down, lines may be drawn and scaled at the same time. Vertical lines up to three inches apart can be drawn very accurately



if a little care is taken when the graduating is done. The protractor, although small, will be found useful to quite an extent. It can be purchased of any dealer in draftsmen's supplies and after the edge is beveled it can be sprung into the circular recess previously bored in the body of the triangle.

A DEVICE FOR CLAMPING FLAT WORK.

"Student" sends the accompanying sketch of a clamping device for use on planers, shapers, or milling machines for holding flat pieces of work. This clamp is bolted to the platen *H* with the bolt *G*, and the bottom of the casting is planed with two slots for the key *B*. One of these slots runs lengthwise and the other crosswise so that the key can be set at right



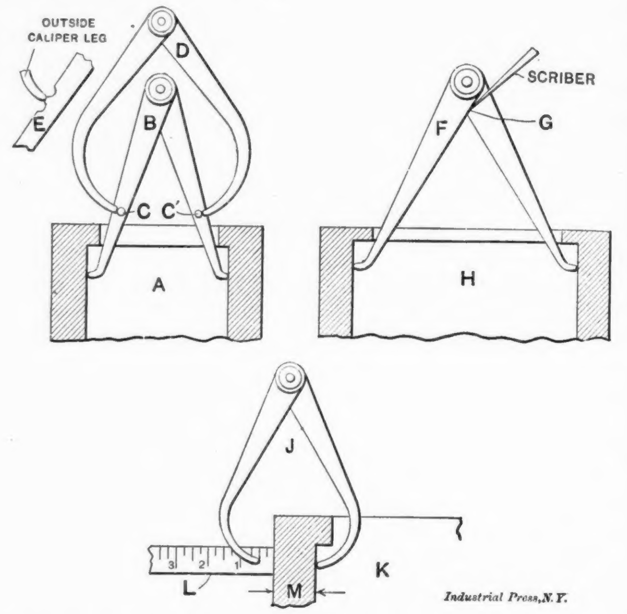
angles to the travel of the table, thus offering greater resistance to the milling cutter; or it may be set parallel with the table and thus bring both dogs in line.

These clamps are used for holding such work as valves, valve-seats, flanges, or any flat work which is placed down on the seat *E*; the setscrew *D* is then tightened, thus forcing the steel point *F* downward and into the work. The same operation performed upon the other end securely clamps the work.

SOME MAKESHIFTS WITH CALIPERS.

Of course the machinist who is up-to-date has a set of transfer calipers so that he is able to take measurements over flanges, etc., but it sometimes occurs that these convenient tools are not at hand when such measurements are to be taken. This is likely to occur on repair jobs when only the most necessary tools have been taken along. In such cases the accompanying cuts show some of the makeshifts that have been used. To measure the inside diameter of a bore having a shoulder like the piece *H* the inside caliper *F* is set as usual, and then a line is marked with a sharp scriber on one leg by drawing it along the side *G*. Then the legs are closed to remove the caliper, and are reset to the scribed line. Of course this method will only do for an approximate measurement, but it is surprising how close it may be made if care is taken, especially on small diameters with large calipers.

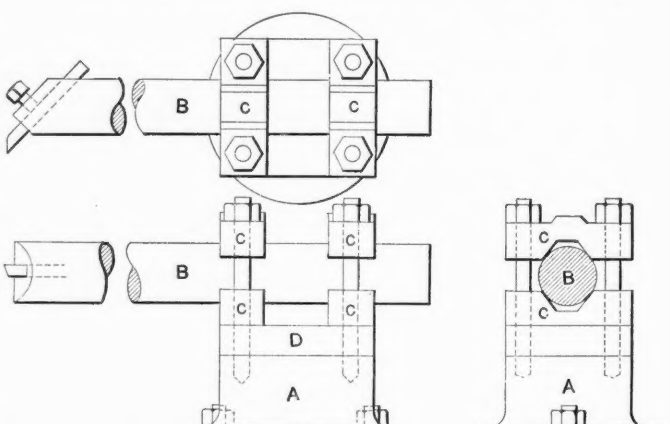
Close measurements may be made by filing two notches in each leg so as to leave a rounded projection between, as shown at *E*. Then with an outside caliper, *D*, the setting of the inside caliper, *B*, is taken from the rounded points. The inside caliper can be reset very accurately after removal by this method. A still better way is to have two short pins, *C C′* set in the sides of the inside caliper legs, but this is not readily done as a makeshift.



To get the thickness of a wall beyond a shoulder as at *K* set the caliper so that the legs will pass over the shoulder freely, and with a scale measure the distance between the outside leg and the outside of the piece. Then remove the caliper and measure the distance between the caliper points. The difference will be the thickness *M*. **E. R. F.**

A HANDY BORING BAR HOLDER.

J. C. W. B. sends a sketch of a boring bar holder that will commend itself to the lathe hands who have been troubled by springing, chattering and digging in of the ordinary tool on heavy work. The bar *B* is firmly secured by two pairs of V-clamps *C*, which are fastened by studs to the main casting *A*, the latter being bolted to the cross slide of the lathe in place



of the compound rest. The bar shown is 2½ inches in diameter, but smaller ones can be used in the same holder by blocking up the lower clamps. For facing off work or for ordinary turning the upper clamps and bar are removed and the tool inserted between the lower clamp *D* and the base *A* in the same manner as in the tool holders of the heavier lathes and planers.

* * *

Liege, Belgium, is one of the greatest industrial cities of Europe and is world-renowned for the quality of its firearms and gun barrels.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

17. H. J. inquires in regard to the use of shade lines, whether the additional weight to the line shall be added to the inside or outside of the boundary lines, raising the point that unless some definite rule is followed confusion will arise, when scaling a drawing, as to which side of the line is to be scaled.

A.—We do not think that there is any rule that is generally followed in drafting rooms, since shade lines are usually used only on detailed drawings on which the dimensions are given so that scaling is unnecessary. If, however, a definite rule is to be followed it should be to place the shading on the side of the line farthest from the source of light. There are a number of theories regarding the use of shade lines but in practical use the rule is to shade the bottom and right-hand lines, on the assumption that the light strikes the object at an angle of 45 degrees, from the left. In Figs. 1 to 3 this

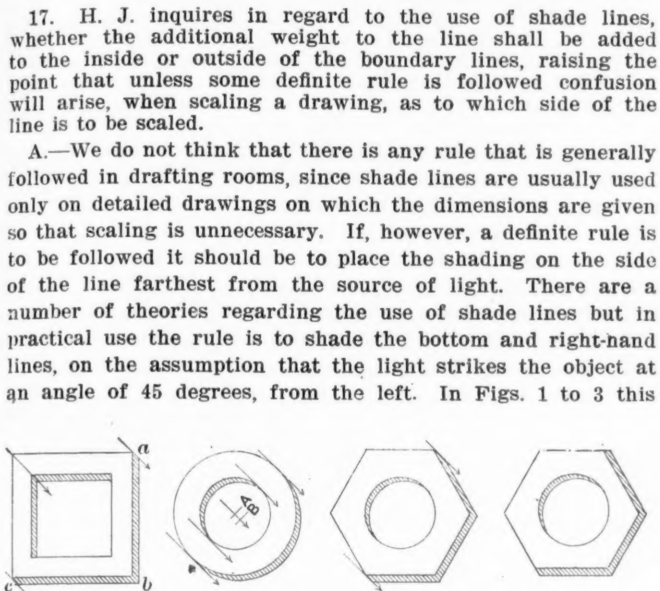


Fig. 1 Fig. 2 Fig. 3 Fig. 4

Industrial Press, N.Y.

principle is illustrated with shade lines of exaggerated weight. In Fig. 1 the light comes in the direction of the arrows, at an angle of 45 degrees and consequently casts a shadow, or makes a shade line from *a* around *b* to *c*. On the inside of the hole the same principle would apply, thus causing the shade to be placed on the inside of the hole. In shading a circle the shade would be drawn with the same radius as the circle but with the center shifted to the lower right-hand on a 45 degree line, as from *A* to *B*, Fig. 2.

Another reason for putting the shade lines on the outside of the boundary lines is that the outline of the figure is not thereby distorted. Figs. 3 and 4 show two views of a hexagon nut blank which have been shaded in both ways. In Fig. 3, which is correct, the shading is on the outside of the lines and it will be seen that the outline of the figure remains in its true proportion, while in Fig. 4, where the shading is placed on the inside of the lines, the outline of the figure is considerably distorted.

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18. E. W. G.—When the crankpin of an engine is at the top quarter and the crosshead moving toward the cylinder, is the engine said to be running "over" or "under?" Why is an engine said to be running "under" or "over?" How can it be determined in an engine of the Westinghouse type which way it is running?

A.—The terms "running over" and "running under" are or should be applied only to horizontal engines, as they are meaningless when applied to vertical engines. Stand back of the engine cylinder (that is, back of the rear head) and look toward the shaft. If, while the crosshead is moving away from the observer the motion of the connecting-rod is entirely above the center line; or in other words, if the connecting-rod appears to pass over rather than under the axis of the shaft, the engine is said to be running over. If the reverse is true, the engine is running under. To answer your first question directly, the engine in that case would be running under; but if the crank were at the top quarter while the crosshead was traveling away from the cylinder, the engine would be running over. Why these expressions are used we do not know and can only guess. It is natural to consider the outward stroke of an engine as the leading stroke, and when the connecting rod appears to the eye to be passing over the shaft center during this stroke, it is natural to speak of the engine as running over. One obtains a distinctly different mental impression in watching an engine running over from what is received when it runs under. We believe the terms have come naturally as a result of these impressions. With vertical engines the effect on the eye is the same, whichever way the engine is running. The connecting rod, being suspended from above, does not appear to be passing over the shaft center when running in one direction more than when running in the other direction.

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19. C. W. J.—Kindly give me your opinion on setting up an emery wheel in a shop. Should it be so placed that the man who is grinding is facing the light (that is, a window), or so that his back will be toward the window? Also, the same question with reference to the location of a lathe. Our lathes are all set so that our backs are toward the windows. Is this the right or wrong way, and why?

A.—The question of the location of a tool near a window appears to be a question of which is the lesser of two evils. With the workman's back to the window he stands constantly in his own light. With the workman facing the window, he will find that the work itself is always in its own light; or in the case of the grinder, that the wheel tends to cast a shadow over the tool. In shops having plain glass in its windows, the light is likely to be glaring and disagreeable to one facing windows on the sunny side; but with the modern corrugated glass, or with suitable shades at the windows, this is not serious and the writer of this note prefers to face the light when working at a tool. One reason is that it is sometimes convenient to be able to "see light" between contact points, when calipering, etc. The ideal way is to locate the tool at an angle of 45 degrees with the window, so that the workman stands with his back and one side turned partly toward the window. The light then reaches the point where the tool is operating and no shadow is cast. Other and more important considerations, however, make it inconvenient to have tools placed in this manner. We should be pleased to have the opinions of readers upon this subject of tool location.

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20. L. M. O.: What is the difference between a plug valve and a piston valve as applied to steam engines?

A.—A plug valve is a cylindrical valve that works in a direction parallel with its axis, and is made with no means of adjustment to compensate for wear. Plug valves work well when new if accurately fitted, especially on vertical engines, but the inevitable wear soon makes them very wasteful because of the great leakage of steam. A piston valve is a cylindrical valve similar to a plug valve but provided with expansion packing rings to follow up the wear. The chief advantage of the plug and piston valves over the D-valve is that they are in perfect balance at all points of the stroke, but with steam-set packing rings the piston valve is far from being frictionless. In fact, it is said that in some cases locomotive piston valves work as stiffly as the old unbalanced D-valve. This defect has led to the invention of the American semi-plug valve which is a piston valve made so the packing rings are free to follow up wear when steam is shut off. When steam is admitted, the packing rings are instantly locked solidly in position so that no further expansion can take place, thus practically converting it into a plug valve for the time being.

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21. T. R. M.—Will you please tell me how many flutes should be cut in an ordinary straight reamer, and advise me whether it is better to use an even or an odd number of flutes.

A.—It is never best to use less than five flutes for, if a less number be employed, the reamer is apt to follow any irregularities in the bore and fail to produce a round hole. With five or more flutes the reamer is not able to follow these irregularities, so as large a number of flutes should be used as the size of the reamer and the strength of the blades will permit. If an even number of flutes, evenly spaced, are used, there is a tendency for the reamer to vibrate, since in reaming irregular holes the greatest load will come on two opposite blades; for this reason it is customary to use an odd number of flutes which results in the greatest load being carried upon at least three teeth. The same result is also obtained by employing an equal number of teeth, but spacing them irregularly.

NEW TOOLS OF THE MONTH.

A RECORD OF NEW TOOLS AND APPLIANCES FOR MACHINE SHOP USE.

HEAVY GRINDING MACHINE.

The Norton Grinding Machine Co., Worcester, Mass., have extended their line of heavy grinding machines by placing on the market an extremely heavy 18-inch machine, for work having a length up to 14 feet between centers and weighing up to 7,000 pounds. This machine for this diameter of work has heretofore been built only for work up to 96 inches long. The weight of the machine complete is about 22,000 pounds. The base is 22 feet long, and weighs 10,500 pounds. The spindles in head- and tail-stock are massive, having center holes three inches in diameter. The wheel spindle and its bearings are mounted upon a slide at the rear of the bed, and weigh, with attached parts, about 1,400 pounds.

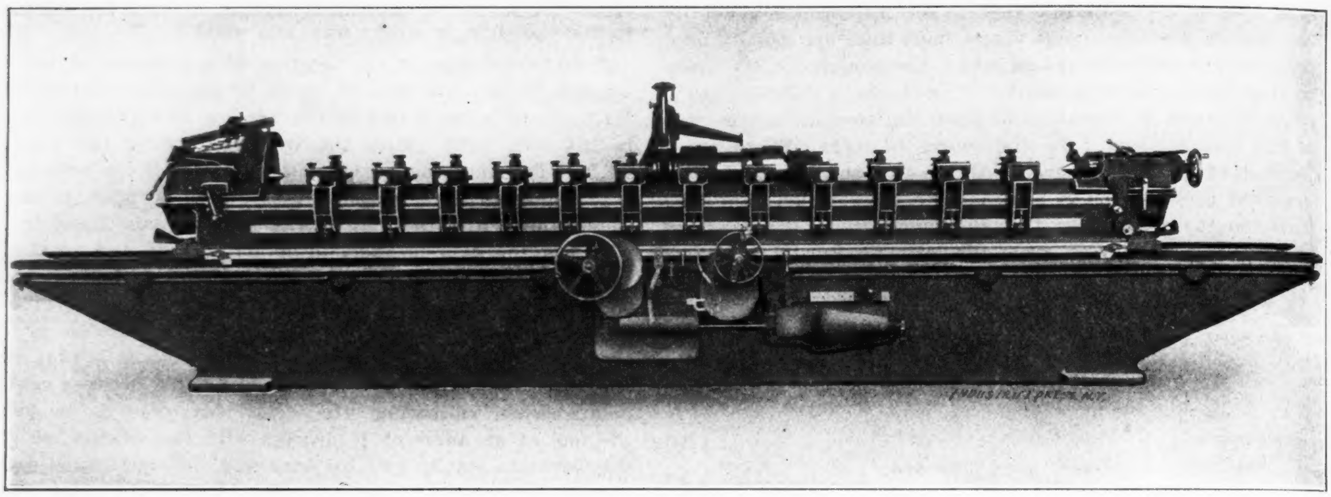


Fig. 1. Norton Heavy Grinding Machine.

Fig. 1 is a front view of the machine, and Fig. 2 an enlarged view of the mechanism seen near the center of Fig. 1, the covers being removed to show the cone, gears, etc. At the right, in Fig. 2, is the speed frame containing speed cone and gears for regulating the speed of traverse of table. By the use of the gearing in connection with the cone fourteen changes of speed are available for the table.

This speed cone drives the gear mechanism seen at the left in Fig. 2 and shown removed from the base in Fig. 3, this mechanism serving to move the table either by hand or power, automatically reversing at the end of the travel.

The group in the center of Fig. 2 is for the movement of the emery wheel forward or back. The extent of the movement is governed by a small dial and crank shown near the top of the index wheel in Fig. 2. The dial has eight holes, equally spaced, and when the ball handle at the center is screwed up tight the lever on which the dial is fixed is made fast to the stud. The operator may then move the emery wheel forward or back by turning the small crank seen on the dial, the movement of the crank from one hole to another giving a change of diameter of work of one-quarter thousandth of an inch. When the ball handle is released the wheel may be moved to or from the work by means of the machine handle at the bottom of the index wheel. This index wheel has teeth on its periphery, which mesh with a small pinion on the axis of the small crank on the dial. The teeth also serve as ratchet teeth, and when the pawl shown at the left of Fig. 2 is thrown into contact, the wheel is fed to the work automatically, a certain definite distance.

The index gear wheel has upon its hub a pinion which meshes with a larger gear, and this gear is fast to the end of the cross-feed screw which passes underneath the work and to the cross slide carrying the emery wheel. In Fig. 4 is a partial side and rear view of the index wheel and cross-feed screw, which latter is of high carbon steel, 3½ inches diameter.

This screw has a bearing in the bracket at the right, Fig. 4, and also a half-round bearing in a massive casting, bored and finally scraped to fit the screw. The combined tops of the thread are equal to a bearing of steel 3½ inches in diameter by 4 inches long, this, however, being distributed over the entire length of 18 inches of the threaded portion.

The half-round bearing for the screw is fast to the under side of the cross slide base and underneath is an oil channel and oil pocket which provide for the lubrication of the screw.

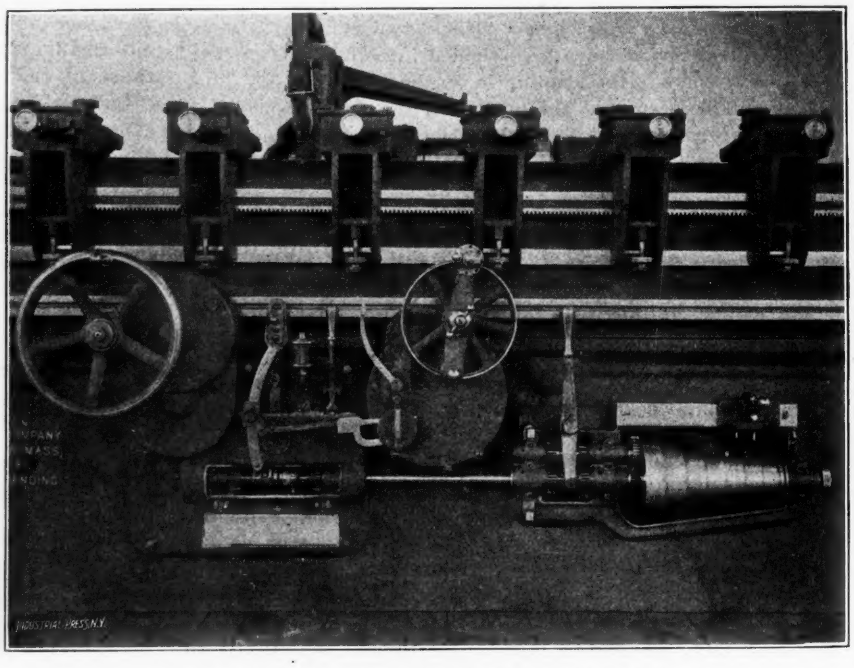


Fig. 2. Enlarged View of Mechanism, showing Cone, Gears, Etc.

The nut for the screw is a half nut 10 inches long, fast to the wheel slide, and its threads are accurately scraped to have a uniform bearing on the threads of the screw. The thrust of the screw is taken by its point, which is beveled and bears against a bronze plug imbedded in a very massive casting. The bearing for the screw being on the anvil principle, and the thrust plug being imbedded in an anvil, so to speak, make it possible to index for one-quarter thousandth diameter

and to move the wheel slide one-eighth thousandth inch accurately. The screw, if moved at all, must revolve; it cannot swing to the right or left, or bend down away from the nut.

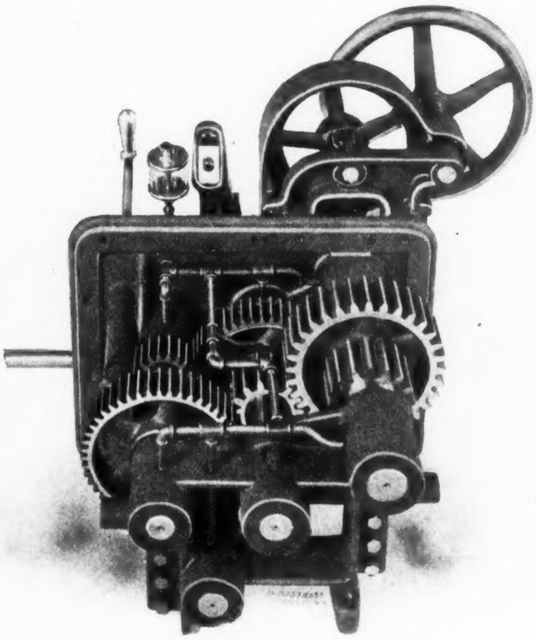


Fig. 3. Detail of Gear Mechanism.

It is possible with this machine to remove any amount of material from steel from a quarter thousandth up to four or five thousandths on the diameter, according to the area of the surface of the work, and obtain accurate measurements automatically or by hand indexing.

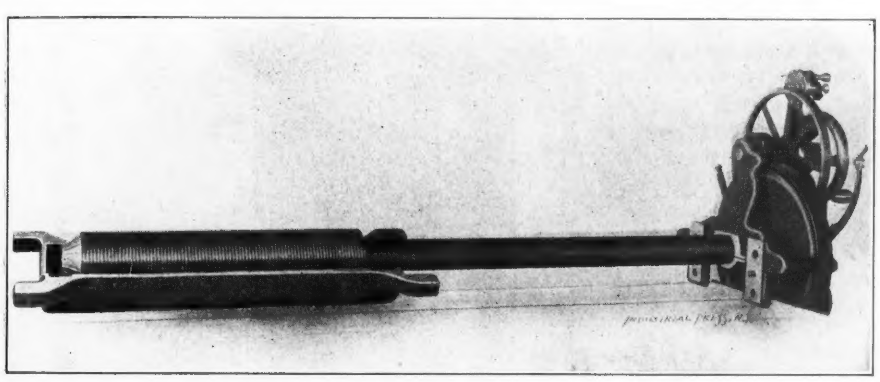


Fig. 4. Index Wheel and Cross-feed Screw.

We are informed that an operator, after measuring the work for a given size, and then setting his micrometer five thousandths under this size, can set the machine to grind off that amount of stock automatically without any "cut and try" business. Then, when the machine has completed the work according to the setting, the latter will be found exactly to size, according to the setting of the micrometer.

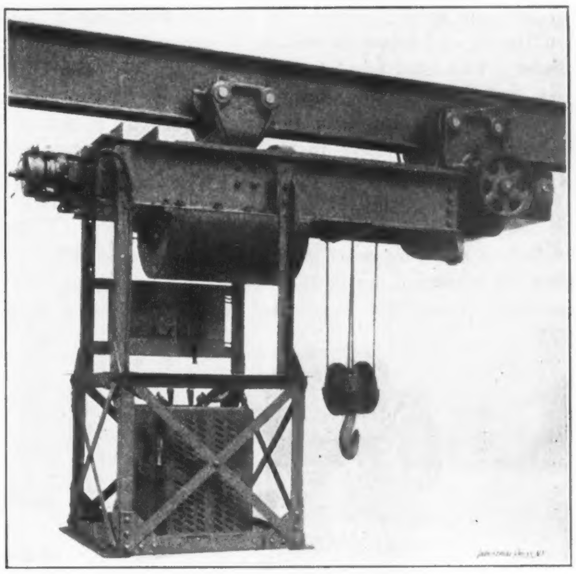
The motion of the table is started and stopped by the lever shown near the oil cup. At the left of this oil cup is the reversing lever. It will be seen by this grouping of mechanism that the operator can adjust the position of his wheel for measuring the work, change the speed of his table, stop and start the table, reverse the table by hand, move the table by the handwheel and adjust the steady-rests, which are shown at the top of the picture, without moving from one point, whatever the length of work may be.

The revolution of the work is varied by a movement of the slide at the top of the head stock, which guides a belt up and down the cone.

The head- and foot-stocks of this machine weigh about 400 pounds each. The swivel table, with its mate, the sliding table, weigh about 5,500 pounds. These, with the large number of steady-rests furnished, form a moving anvil upon which the work revolves, which is sufficient to prevent vibration when the wheel is worked up to the capacity of the power in the machine. This latter is sufficient to remove from nearly all diameters, 1 cubic inch of steel per minute.

NEW ELECTRIC TRAVELING HOIST.

The Niles-Bement-Pond Co., at their crane department in Philadelphia, are building a new style of electric traveling hoist, which we illustrate herewith. The hoisting mechanism



New Electric Traveling Hoist.

is placed between the channel framing of the trolley and is direct geared to the drum, a standard load and motor brake being provided. The power for hoisting is furnished by electric motors, in all cases, while the travel may be arranged for by motor or hand racking. Where curved tracks are used swivel trucks will be furnished. The hoist is built in three sizes, of 3, 4 and 10 tons capacity. It may be equipped with a cage, as shown, or arranged to be operated from the floor by means of pendant controllers.

NEW TEN- AND TWELVE-INCH SPEED LATHES.

The Seneca Falls Mfg. Co., 330 Water St., Seneca Falls, N. Y., manufacturers of the "Star" screw-cutting engine lathes for foot or other power, have placed 10- and 12-inch speed lathes on the market, one of which is shown below. The spindle is made from a crucible steel forging, has a large hole and runs in phosphor bronze bearings which are self-oiling and dust-proof. Each bearing is oiled by a double set of wicks, and the surplus oil runs back into the oil wells,

New Speed Lathe.

which prevents dripping and waste of oil. After once oiling, the lathe will run for a long time without attention in this respect. The cone pulley is turned inside as well as outside, producing perfect balance. The tailstock is of the curved or cut-under pattern, and the tail spindle has a new combination screw-and-lever motion, with graduated dial. The dial is graduated to sixteenths, is useful for drilling, counterboring, countersinking, etc., to a desired depth, and can be moved and set at any point. To change from screw to lever motion the thumb-screw is loosened, which releases the spindle sleeve. The long hand lever can be lifted off when not in use. A hand-rest is provided, with short and long T-rests; rest socket and saddle are locked to the bed by a cam-locking device, and T-rest is held in the socket by a friction clamp, doing away with the setscrew commonly used. These rests and the tailstock clamp are operated by levers, always attached, so that no wrenches are required.

The bed is provided with a flat front way and with a back way that is V-shaped, as in the "Star" engine lathes. Secured to the back of the bed is a shelf for the reception of tools, etc. The countershaft has self-oiling and self-aligning shaft bearings; and tight and loose pulleys, or friction clutch pulleys are furnished, as desired.

Each lathe is provided with faceplate and two point centers; and, when specified, slide rests, draw-in chuck, collets, etc., are supplied. The lathe can be furnished mounted on oil-pan or bench legs; also with foot power in place of countershaft.

PORTABLE SLOTTER AND PORTABLE BORING, DRILLING AND MILLING MACHINE.

We illustrate herewith two new machines brought out by the Newton Machine Tool Works, Inc., Philadelphia, Pa. One is a portable boring, drilling and milling machine, the other a 48-inch portable slotting machine. The boring, drilling and milling machine, Fig. 1, is specially adapted for work on large electric motors and dynamos. It has a boring bar 4¼ inches in diameter, with an automatic feed of 39 inches, with three changes, a hand feed and a hand quick return. The spindle head is counterweighted and has power quick movements in the upright, operated independent of the spindle, in either direction, by reversing the motor. It also has two changes of automatic feed, for milling. The speed changes are obtained mechanically by changing the gearing between the motor and the driving shaft.

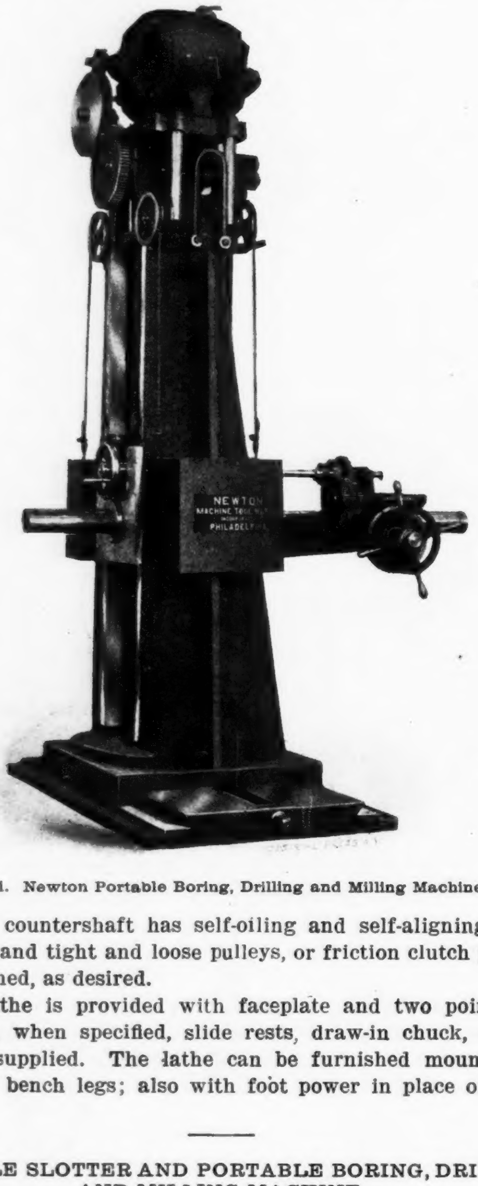


Fig. 1. Newton Portable Boring, Drilling and Milling Machine.

The uprights have an adjustment on the base of 30 inches. The maximum distance from center of spindle to floorplate is 6 feet, 10 inches; the minimum distance, 22 inches. The machine herewith has a fixed upright, but it may be made with a swiveling upright when desired.

The slotting machine, Fig. 2, is for very heavy work beyond the range of regular slotting and planing machines. The ram of the machine is counterweighted, the counterweights running inside the frame, and it has a stroke of 48 inches. The ram is driven by a spiral rack and pinion, by means of a 10 H. P. motor, the reverses being operated by a magnetic clutch, which makes the machine very compact. The tool slide has a cross feed of 30 inches and an in-and-out adjustment of 4 inches.

This machine can be clamped in any position on the floorplate to suit the work, and is also made on a sub-base, giving an adjustment to the entire upright without unclamping it. It is especially adapted for work on dynamo frames and rings and can be used to advantage in the manufacture of large engines.

Fig. 2. Newton Portable Slotter.

NEW CUTTER GRINDER.

The Heald Machine Co., Worcester, Mass., have brought out a wet cutter grinder for grinding formed cutters, gear cutters, hobs, taps, forming tools, etc., and which is also fitted with an attachment for grinding lathe and planer tools. It is the experience of this company that cutters ground with a dry wheel, after the usual custom, do not stand up to the work as they should, even when the greatest care is taken in grinding; and the conclusion was reached that it would be more desirable to grind cutters in the presence of an abundance of water, so that there should be no overheating at the cutting edge, even when grinding off the relatively large amount necessary in cutters of this form. It was believed that water is as necessary in cutter grinding as in the cylindrical grinding of general machine work.

The results of the company's experiments are embodied in the machine shown in Fig. 1, next page. It consists of a base

and column provided with a grinding wheel mounted in a double carriage at the top, and a square trough-shaped casting, adjustable up and down on the front of the column, in which the work holder is carried. This work holder can be swiveled to any desired angle with the wheel, and placed either in a right-hand or left-hand position.

A swivel head is also provided and the machine is adapted for grinding all kinds of milling cutters, both angular and plain, as well as for grinding forming tools.

The tooth rest (see detail view, Fig. 2), instead of being flexible, after the usual construction, consists of a short rod which can be adjusted out or in for setting the cutting faces against the wheel, for the purpose of giving a very rigid support to the cutter tooth while grinding. The finger swings out of the way to the right or left, to allow the cutter to be turned upon its axis. The wheel is traveled through the work by the hand lever at the side of the column. The work is raised and lowered by means of the hand-wheel and screw, which gives a quick and accurate adjustment of the work to the wheel. A water tank at the base of the column, with a centrifugal pump, furnishes an abundant supply of water to the work; while water guards are provided to keep the water where it belongs, so that the other parts will remain dry and in good condition.

The work holder, while simple, is quite universal in its range and will hold both straight and taper spindles, right-

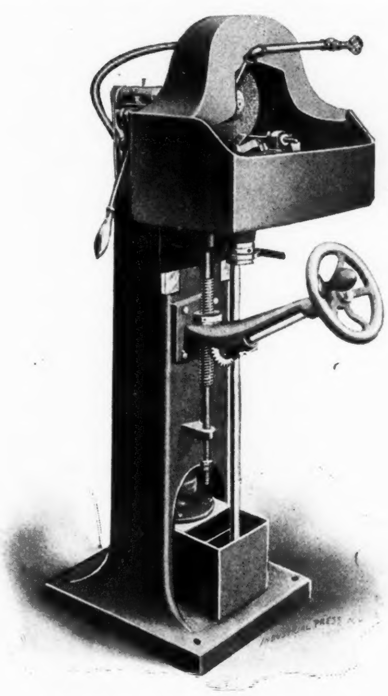


Fig. 1. Heald Wet Cutter Grinder.

or left-hand cutters, whether straight or angular; also flat forming tools, threading cutters, etc., which are ground on their faces in sharpening.

The attachment for grinding lathe and planer tools, shown in Fig. 3, consists of an L-shaped casting which will swivel on the base to any angle. It carries a spool for holding the tool, which will also turn about the axis of the tool, these two adjustments giving practically any setting needed for such work. Each axis of the holder is fitted with a graduated dial, and the point of the tool can be elevated or depressed to any required angle within the spool, which gives additional adjustment.

The machine is furnished in three styles: One, for cutters, etc., alone; another, for cutters with the tool grinding attachment, and a third, for grinding tools only.

LARGE AUTOMATIC GEAR CUTTING MACHINE.

What is said to be the largest entirely automatic gear-cutting machine ever built has just been completed by Gould & Eberhardt, Newark, N. J., for the R. D. Nuttall Co., Pittsburg, Pa. The company state that there have been larger machines manufactured for this class of work, but these have been of the semi-automatic type, whereas this machine after once being set and started needs no further attention until the gear blank is completed.

The machine is shown on the following page. Being designed for coarse-pitch, heavy gearing, it is arranged so that the gear blank will lie down flat on the ways of the bed, instead of being supported on an arbor, between two upright

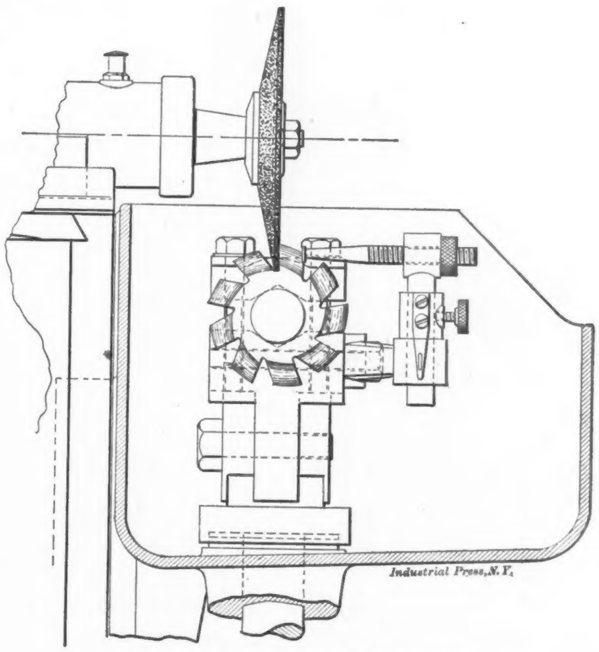


Fig. 2. Enlarged View of Cutter Grinder.

columns, as in their smaller machines. This makes a very rigid support to the gear blank; the machine is laid out on the anvil principle, to carry the weight, take the strain of the cut and absorb vibrations when cutting.

The cutter slide works up and down in a vertical position, on an upright stanchion, which is movable longitudinally on the bed either by hand or power. The work barrel and ar-

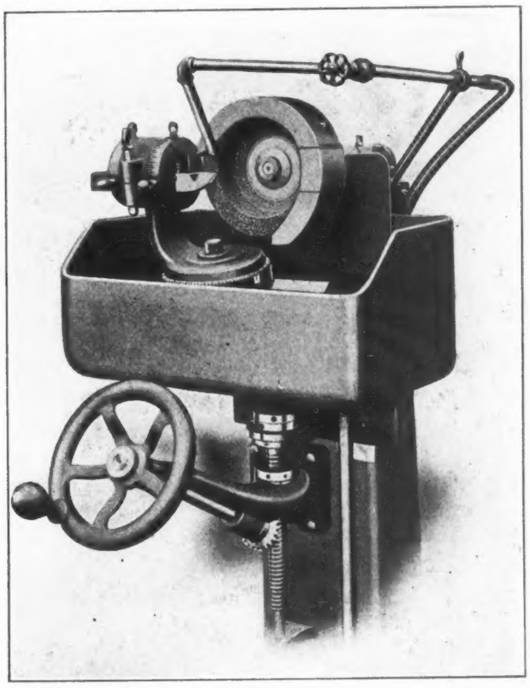


Fig. 3. Attachment for Grinding Lathe and Planer Tools.

bor, and also the worm dividing wheel, are rigidly fixed to the machine bed; and the positioning of the cutter in relation to the gear blank is obtained by moving the upright stanchion on the bed. Its exact movement to a fixed distance is located by means of a graduated dial and scale, with a stop which can be set at any predetermined point.

The cutter slide has a long and narrow guide flat bearing

on the ways. It is counterbalanced by a 3,000-pound weight, held by two cables which pass over double grooved pulleys mounted on top of the stanchion. The cutter spindle has a powerful worm and wormwheel drive, and in addition to the regular cutter spindle for the use of large-diameter, coarse-pitch cutters, an auxiliary cutter spindle is furnished for using cutters up to as coarse as 1 diametral pitch. The bearings for the cutter spindle are heavily proportioned.

The worm dividing wheel is of large diameter and as is the practice with the company's smaller gear-cutting machines, it is made in halves, doweled together and hobbed. A guard protects it from all chips and dirt, etc. The chips, and also the lubricant used for the cutter, drop into a compartment below. the lubricant being separated by gravity and flowing into a pocket in the base from which it is again pumped to the cutter.

Divisions for the different numbers of teeth are arranged to be made entirely automatically through combinations of gears, but the machines can also be arranged so as to be operated semi-automatically, and the dividing mechanism tripped by hand for each tooth, if desired. In a test made of a 10-foot gear blank cut in this machine, the greatest error between any two teeth was .0015 inch.

Only one belt is used to drive the entire machine, and all movements are actuated through splined shafting and gearing. Each movement is complete in itself, and cannot take place unless all previous movements have been fully and correctly completed. A very essential feature of the con-

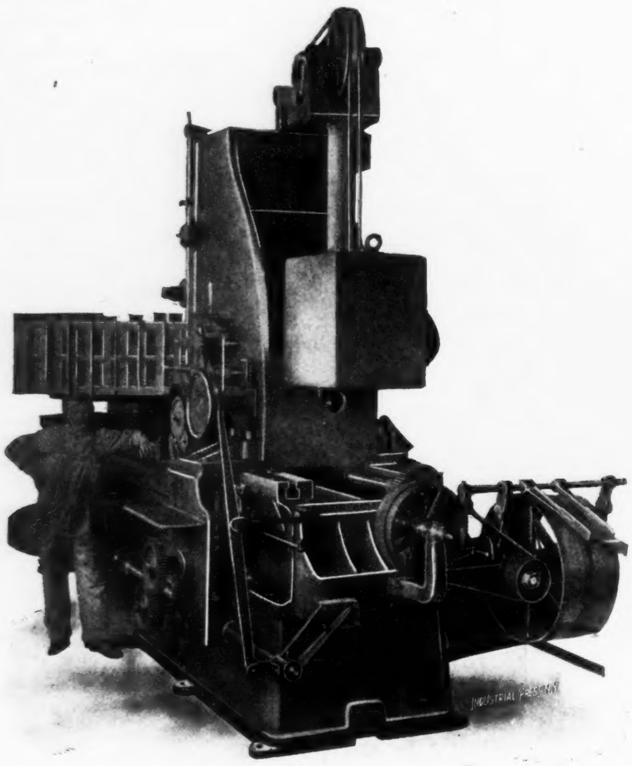


Fig. 1. Rear View showing Counterbalance and Driving Gear.

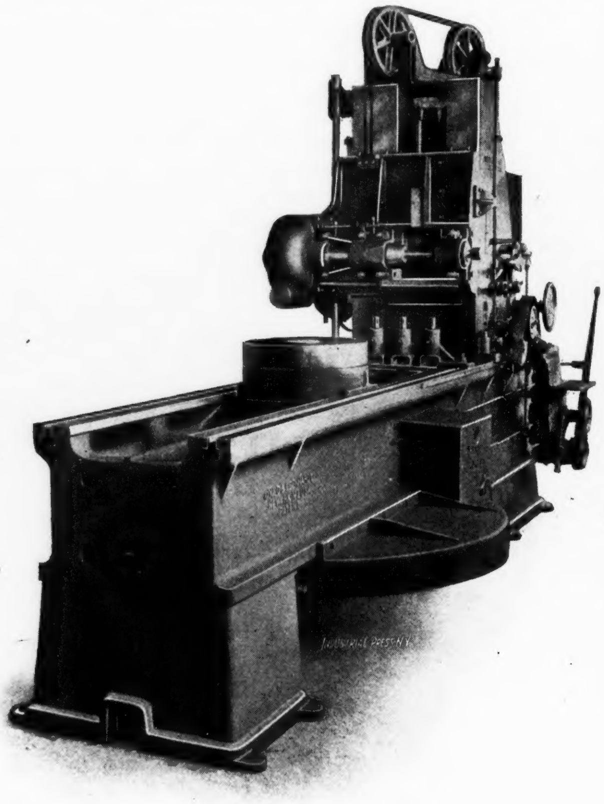


Fig. 2. Front View of Automatic Gear-cutting Machine.

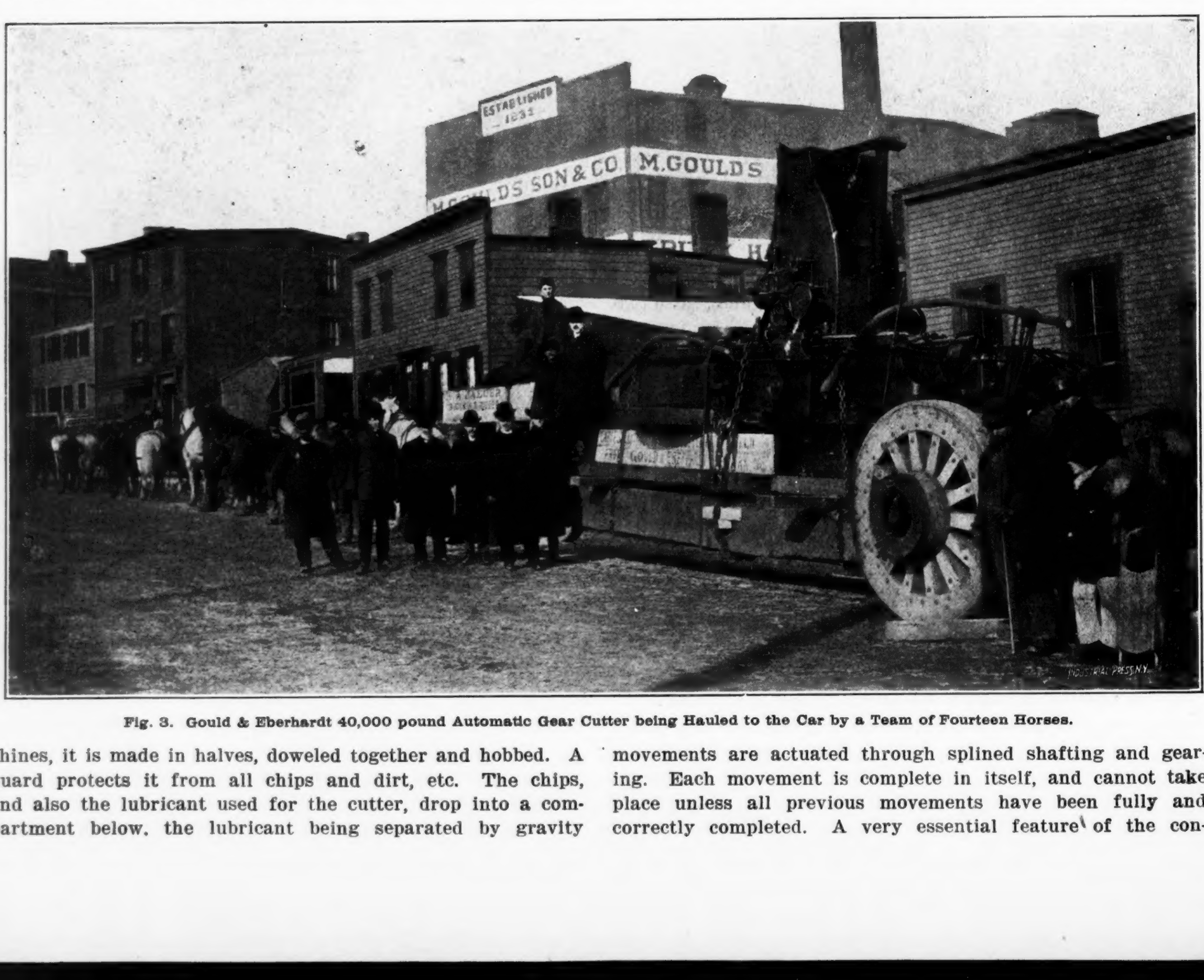


Fig. 3. Gould & Eberhardt 40,000 pound Automatic Gear Cutter being Hauled to the Car by a Team of Fourteen Horses.

struction provides that unless the division of the worm-wheel is made complete, the cutter carriage cannot possibly feed forward. This always takes place entirely automatically, and requires no adjustment whatever, for any size of gear.

ELECTRICALLY-DRIVEN TRAVERSE SHAPER.

The accompanying half-tone engraving shows a single head traverse shaper, built by the Cincinnati Shaper Co., Cincinnati, Ohio, as it has recently been equipped for motor-drive. The motive power of this shaper is furnished by a 7 horse power Crocker-Wheeler variable speed motor operating on the four wire system, which is attached to the base at the rear of the machine. The pinion of the motor shaft meshes into a gear on an intermediate shaft carrying a positive clutch which may be thrown into one or the other of two sets of gears connecting with the driving shaft of the machine. The controller for the motor is mounted on a bracket attached to the saddle and is shown at the left-hand end of the saddle in the illustration. With this method of attaching the controller the operator has full control of the machine when standing in position in front of it, as on these shapers all of the feeds are directly operated from the saddle. The electrical connection of the controller with the motor is shown in the line drawing, Fig. 2. The wires from the controller are supported over the bed of the machine by being placed in a piece of wrought iron pipe that is attached to the saddle at the rear of the controller. The wires from this box to the motor and to the panel stand, which is placed at the right of the machine, are likewise enclosed in pipe so that all danger of injury to any of the connections is prevented. This machine has a capacity for taking work up to 24 inches in width and 8 feet in length.

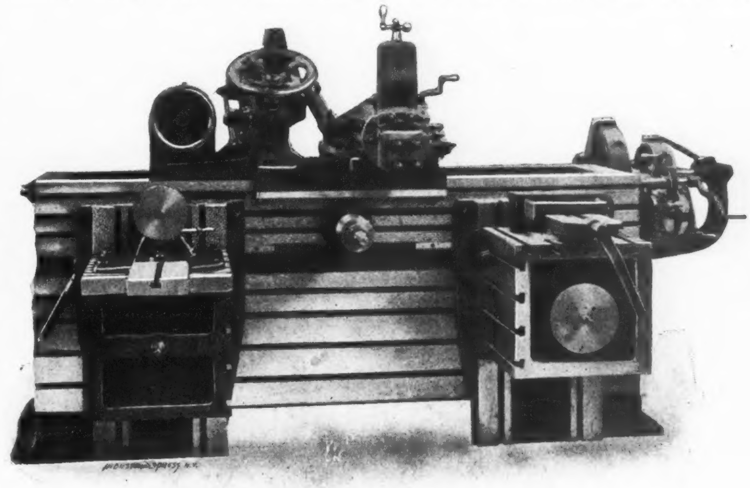


Fig. 1. Electrically-driven Traverse Shaper.

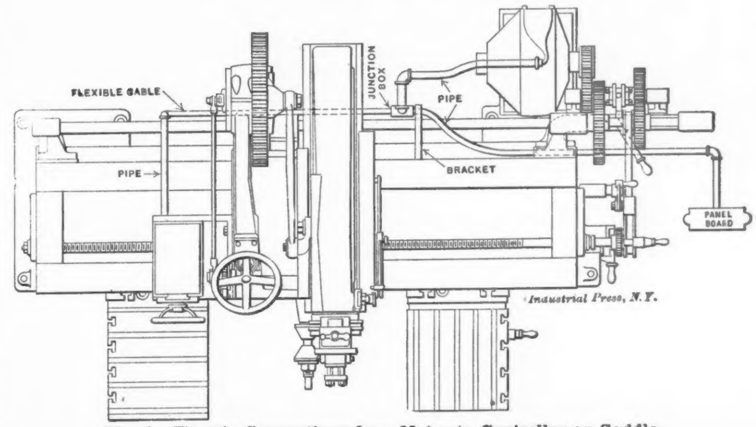
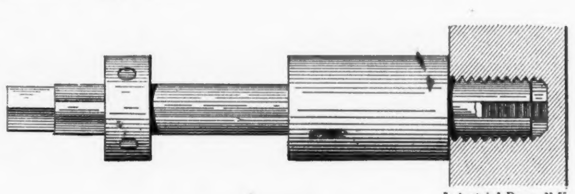


Fig. 2. Electric Connections from Motor to Controller on Saddle.

BROKEN-TAP REMOVER.

The cut herewith shows a device which is adapted to engage and remove pieces of taps which have been broken off in a tapped hole. It consists of a cylindrical holder whose diameter is equal to that of the tapped hole, and is provided with a square section at one end to receive a wrench. The holder has longitudinal grooves, corresponding with the longitudinal grooves in the tap, and which receive the sliding tap engaging bars. These bars are fixed at their upper ends in a sliding collar by which they are moved lengthwise on the cylindrical holder. A loose sleeve slides on the holder, and when the remover is applied to a broken tap the sleeve is slid down close to the work, supporting and holding the tap engaging bars in their respective grooves, at the point where the strain is applied.



Broken-tap Remover.

The manufacturers of this device, the Atlas Machine Co., Providence, R. I., state that this device is simple and strong. It engages the broken piece, unscrewing and removing it without damage to the work, and is always ready for instant use. It is made in a set of six sizes, for standard taps, from $\frac{1}{4}$ to $\frac{5}{8}$ inch, and other sizes are made to order.

TWO SIDE TOOLS.

The accompanying illustrations show two new side tools, consisting of holders with specially-shaped cutters of self-hardening steel. One of these tools is offset and is made both right- and left-hand; the other is a straight-shank tool, either right- or left-hand. The holders are drop forgings, of steel, and casehardened, and have dovetail grooves for the reception of the cutters. The depth of the groove and the thickness of the cutters are the same, so that the outer surface of the cutter does not project beyond the outer surface of the holder. The clamp screw bears against the lower beveled edge of the cutter and has a countersunk head which is flush with the surface of the holder. The clamp screw is so near the edge of the holder that the cutter can be used up very short. These tools, made by Armstrong Bros. Tool Co., Chicago, Ill., are supplied in sizes up to $1\frac{1}{4}$ to $2\frac{1}{4}$ for the offset tool, and $1\frac{1}{2}$ by $2\frac{3}{8}$ for the straight shank tool. The former tool is designed especially for lathe work, and the latter for planer work.

Fig. 1. Offset Side Tool.

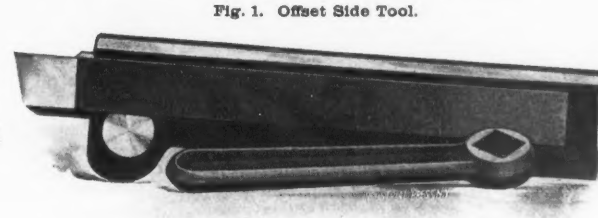


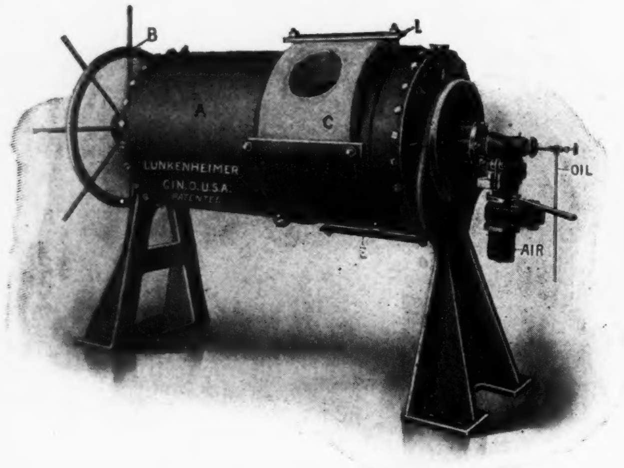
Fig. 2. Straight Side Tool.

LUNKENHEIMER MELTING FURNACE.

The Lunkenheimer Company, Cincinnati, O., have sent us the description herewith of a new melting furnace for the efficient and economical melting of metals, especially brasses and bronzes. It is of the oil-burning type and was evolved

after considerable experimenting with different types of furnaces. It consists of a cylindrical sheet-steel drum, *A*, having cast-iron heads, and whose interior is lined with fireproof tile. There are two openings on opposite sides of the drum, only one of which is in use, the other being closed by a fire-clay filling. As a furnace wears out quicker around the filling hole than elsewhere, when one filling hole is worn out it can be closed and the other put in service. Owing to the simple form of tile, it is easy to replace the lining when worn.

The life of the linings is from 300 to 400 heats, according to the metal melted. The company have ten of these furnaces



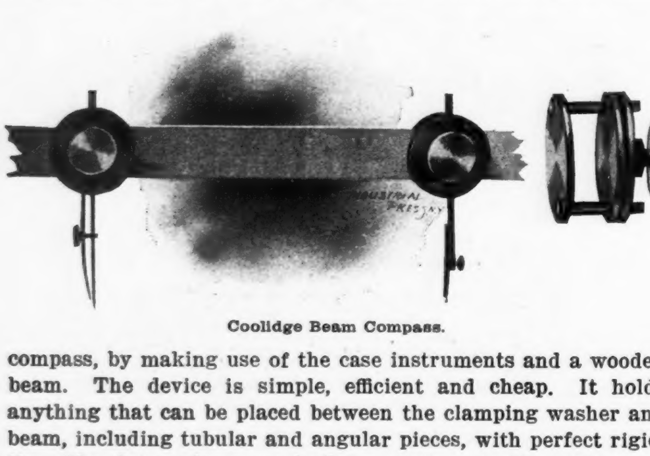
Lunkenheimer Melting Furnace.

in use, and secure from six to seven heats per day of ten hours, from each furnace. The weight of each heat averages about 550 pounds, and the oil consumption varies from 2 to 2½ gallons of crude oil per 100 pounds of metal melted.

The furnace is substantial and durable. It is made in two sizes: No. 1, having a capacity of 550 pounds of metal per heat, and No. 2 a capacity of 1,200 pounds of metal per heat. With the order of each customer within the radius of 1,000 miles of Cincinnati the company will send an expert to start the furnace and take off the first heat, and also instruct the furnace employees how to secure the best results in handling, etc.

COOLIDGE BEAM COMPASS.

Beam compasses of the usual construction are a luxury that many draftsmen do not possess, although a beam compass is an instrument of the greatest utility, even for some work that can be done with the ordinary compasses. Mr. C. E. Coolidge, of Ithaca, N. Y., has attempted to supply a "long-felt want" for something that will take the place of the ordinary beam



Coolidge Beam Compass.

compass, by making use of the case instruments and a wooden beam. The device is simple, efficient and cheap. It holds anything that can be placed between the clamping washer and beam, including tubular and angular pieces, with perfect rigidity. The flat surfaces are buffed smooth and all surfaces are nickel plated. They are manufactured by Mr. A. W. Stephens, Ithaca, N. Y.

* * *

The total weight of rivets used in the United States cruiser *Brooklyn* is said by Naval Constructor J. H. Linnard to exceed 330,000 pounds, or 165 tons. Of this weight one-quarter to one-third is in the rivet heads and points.

FRESH FROM THE PRESS.

PRACTICAL LESSONS IN ELECTRICITY. 300 pages, 7 x 10 inches, and over 100 cuts and diagrams. Published by the American School of Correspondence at the Armour Institute of Technology, Chicago, Ill. Present price 90 cents.

The first edition of this work, which was published to call general attention to the scientific yet simple manner in which the American School of Correspondence papers are prepared, was placed on sale at 70 cents per copy. It is needless to say that this low price barely covered the cost of the paper and binding. In about two weeks the first edition was completely exhausted and a new edition has been issued containing 50 additional pages, making 300 pages in all. The price has been slightly increased, to the figure given above.

The book is compiled from four representative text-books of the school's electrical engineering correspondence course. The chapter on storage batteries was taken from the text-book prepared for the course by Prof. F. B. Crocker, of Columbia University; the chapter on electric wiring from the text-book prepared by Mr. H. C. Cushing, Jr., author of "Standard Wiring;" the chapter on electric current from the text-book by Mr. L. K. Sager; also the chapter on elements of electricity. A list of examination questions is given to afford the reader a means of testing his own knowledge of the subjects treated. In view of the great need for a better understanding of the elementary laws of electricity and the construction of electrical apparatus by machinists and others it would seem that this very cheap and good book should meet with a large sale.

AMERICAN COMPOUND LOCOMOTIVES: A Practical Explanation of the Construction, Operation and Care of the Compound Locomotives in use on American Railroads. By Fred H. Colvin. 142 pages, 5½ x 8 inches, and 42 cuts. Published by the Derry-Collard Company, 256 Broadway, New York. Price $1.50.

The author of this interesting and practical work for railway men was formerly associate editor of *Locomotive Engineering*, and is specially informed on the subject, having made it one of special study for several years. The introductory chapter gives a brief historical account of the compound locomotive in America, with brief reference to the Mallet, Von Borries, Worsdell, Webb and Lindner compounds in Europe. A chapter is given to the theory of compounding steam cylinders, following which comes the descriptions of the principal two-, four- and tandem-cylinder compounds that have been built and placed in operation in America. These in order given, are: Baldwin two-cylinder, Pittsburg two-cylinder, Rhode Island two-cylinder, Richmond two-cylinder, Rogers two-cylinder, Schenectady two-cylinder, Baldwin-Vauclain four-cylinder, Baldwin tandem, Colvin-Wightman tandem, Schenectady tandem, and Baldwin balanced four-cylinder compound locomotive of the De Glenn type. A chapter reviews some of the ingenious plans that have been proposed for balancing locomotives, and then follow chapters on locating blows; on breakdowns; reducing valves; drifting; valve motion; disconnecting, etc.

MACHINE DESIGN, PART II: FORM, STRENGTH AND PROPORTION OF PARTS. By Forrest R. Jones, Professor of Machine Design, Sibley College, Cornell University. 8vo, ix + 426 pages and 243 cuts. Published by John Wiley & Sons, New York. Price, $3.00.

The first edition of Part II of Professor Jones' book on machine design was published in the spring of 1899, and its general excellence was at once recognized. Since then we are pleased to note that it has passed through two editions, the copy before us being one of the third edition. About 80 pages of new matter have been added and over 60 new cuts. The new matter relates principally to ball bearings and belts and ropes for power transmission, the available data on both subjects having been considerably extended during the past few years. The chapter on ball and roller bearings has about 32 pages and 23 cuts, of which a considerable part is devoted to the theory of ball action in races of various shape. The new chapter on belt-drives is particularly valuable. It contains three double-page engravings for the graphic solution of belt-drive problems, and numerous other cuts showing three-pulley drives, etc. Readers of MACHINERY will recognize that much of this chapter is a digest of the articles by the same author which appeared in this journal in 1901. The author has been afforded opportunities for examining numerous belt-drives in mills and factories in New England States which are designed and installed on correct principles. Many are for shafts at right angles under conditions that are more or less complicated. We have often recommended this work to students and others, and, of course, the new edition is of still greater value.

WAIT'S CALENDAR OF INVENTION AND DISCOVERY, by John Cassan Wait. Published by the McGraw Pub. Co., New York. Price, $1.00.

This calendar is issued in book form and is unique among calendars and unique among books. Each day in the year contains the names of two men who either were born, or died on a day of which it is the anniversary, and the men selected for this honor are those who have been more or less noted as inventors, discoverers, scientists or engineers. There is a brief statement of their achievements, also. In addition to this biographical summary, the author has selected a large number of quotations, including poetry and prose, from the great writers of all ages, and one or more selections are published for each day of the year. For every printed page of the calendar there is a blank page for memoranda, and altogether it is a useful and interesting production. The question arises, however: Were the great inventors and discoverers obliging enough to have their dates of birth and death distributed throughout the year, so that in the selection of only two per day no important ones would be left out? Perhaps under the law of averages it would come so, or nearly so, especially since under the author's arrangement each dignitary has two chances to be booked. This calendar is to be issued annually, and it is intended to supply it to manufacturers who would like to present it to their customers.

THE MECHANICAL ENGINEER'S REFERENCE BOOK, by Henry Harrison Suplee. Published by J. B. Lippincott & Co., Philadelphia. 834 pages. Illustrated. Price, $5.00; with thumb index, $5.50.

This is the third American mechanical engineers' handbook to be offered to the public, and is to be recommended as a convenient and undoubtedly a thoroughly reliable engineers' reference book, as far as it goes. The adverse criticism which we have to make is that it does not cover the ground of mechanical engineering with sufficient completeness so that a person with this one book at hand can depend upon finding something upon the important problems which arise in practice. While there are sufficient data in many instances, in others the information is noticeably incomplete, or even entirely lacking. It is to be said, however, that so much painstaking labor is required in the preparation of a work of this character that it is an extremely difficult matter to produce a handbook which at the outset can be classed as complete. Typographically, the book is the handsomest of any of the pocketbooks. The tables are unusually clear and the illustrations are well executed, while the binding, paper and press work are all that could be desired. The book is strongest in its treatment of mathematics which, with mechanics, takes up some 300 pages. Its next strongest feature is that of machine design, there being many details and proportions of parts of machines similar to the information given in the best books upon machine design. These machine details are a new feature for an American handbook and will be appreciated by draftsmen. Of the many other mechanical engineering subjects treated the information is concisely and sys-